CCS Technical Documentation
NPD-1 Series Transceivers

Troubleshooting – RF

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RF Troubleshooting

If TX power is low, turn on transmitter in local mode using Phoenix. Check:

- current (0.7 – 1 A for max power, mode and channel dependent.)
- perform visual inspection of PWB under microscope to check proper placement, rotation, and soldering of components
- Look for presence of TX signal on spectrum analyzer at the correct frequency. If signal is not on frequency, check in 100 MHz span. If signal is present but off frequency, check synthesizer. If signal is not present, or present but low in amplitude, use probing Tables 1 through 5 to determine where in the chain the fault occurs, with AGC PDMs set for known transmit power as listed in Table 1
- Check that AGC PDMs are set for desired TX power according to Tables 1 and 3, and ensure that AGC voltages are correct
- according to Tables 2 (cell/AMPS) and 4 (PCS), check the LOs for proper frequency and amplitude
- ensure power supplies to transmitter have correct voltage, as per Table 12

If Receiver is not working properly, turn on transmitter in local mode and check:

- turn on receiver with Phoenix, inject a signal into the receiver
- check the RSSI level and AGC PDM according to Table 6
- perform a visual inspection of the PWB under a microscope to check proper placement, rotation, and soldering of components
- use probing Tables 6 through 11 to measure signal levels at various points in the chain and determine where in the chain the fault lies
- according to tables 3a through 4b, check the LOs for proper frequency and amplitude
- ensure power supplies to receiver have correct voltage as per Table 5

If phone won't make a call:

- ensure phone is in normal mode (*i.e.*, ensure the phone is searching for a signal, *i.e.,* net server is on).
- ensure Preferred Roaming List (PRL) is loaded into phone

- ensure phone is tuned (read tuning parameters using Batch Tune component in Phoenix, an untuned phone will have all zeros in tuning file), and has passed tuning
- ensure call box channel is set for a channel in PRL, and ensure SID is correct
- ensure MIN, MDN, and SID are entered into the phone
- ensure VCTCXO is centered, as described in VCTCXO tuning description below
- ensure transmitter and receiver are working properly by checking them in local mode.

To troubleshoot the antenna circuits, refer to document DHK00086-EN by Tim Mcgaffigan.

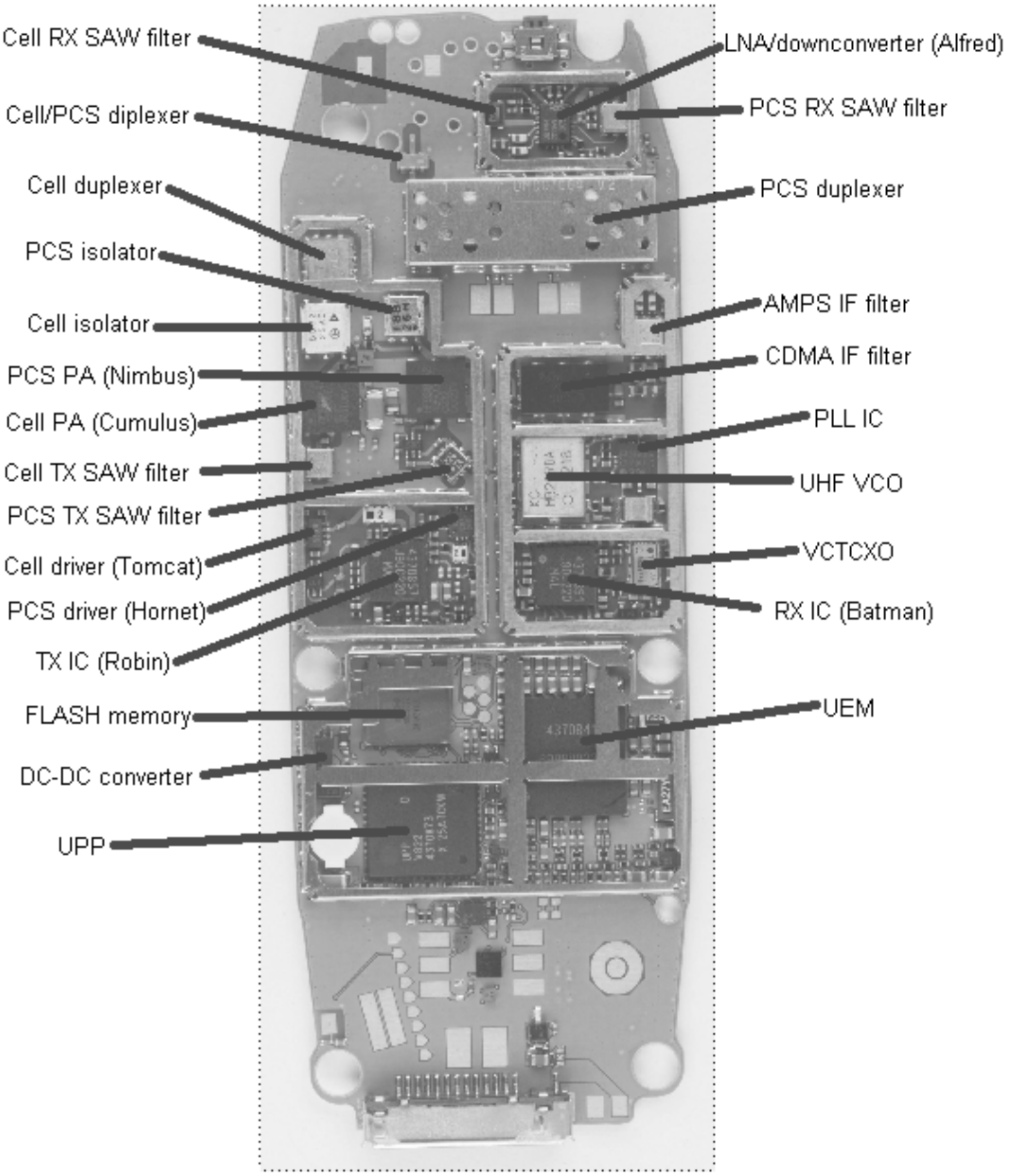

Figure 1: Eagle PWB bottom (general placement)

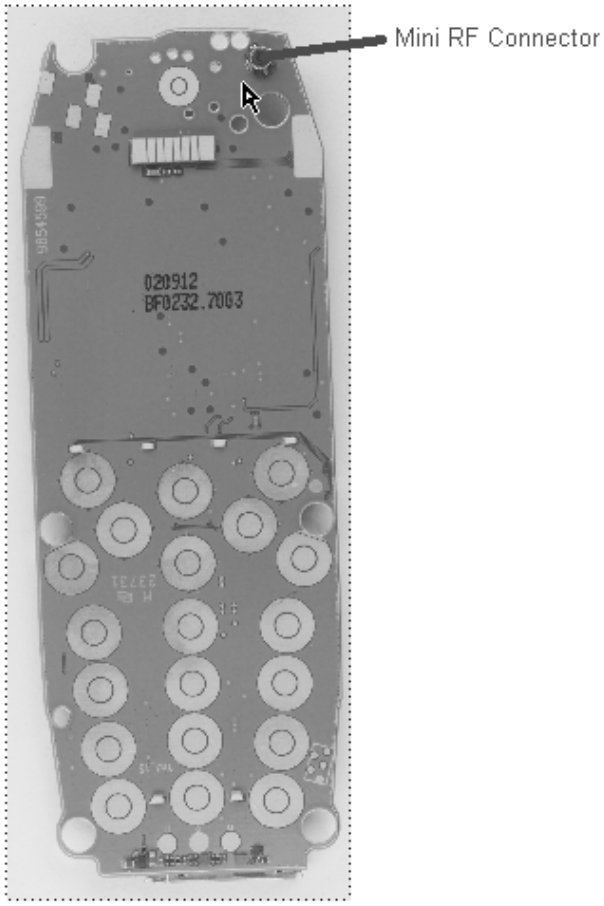

Figure 2: Eagle PWB top (general placement)

Tuning Descriptions

NOTE: Pass/Fail limits are not provided in this document as they may be changed.

ST Batman VHFPLL

This is one of the phone's self tests, which gives either a "pass" or "fail" result only. The VHFPLL is inside the Batman IC. The phone checks the VHFPLL's lock detect bit. If this bit indicates that the PLL is unlocked, the test will fail.

Manual Verification: Turn on the Cell or PCS receiver to any channel and probe at L701 (probing point 39 in Figure 6) using an RF probe connected to a spectrum analyzer tuned to 256.2 MHz. If the PLL is locked, it will be stable in frequency. If it is unlocked, you may have to use a wide span to see it since it may be far off frequency.

Troubleshooting: First check that V701 has the proper orientation, then check C701, C714, R703, R702, C715, R704, C716, L701, and C702. Also check power supplies to Batman, particularly check for 2.7v on VR5 at C710, and on VR7 at C708, and check for 1.8v on VIO. If no fault is found, replace N701 (Batman).

ST TX Detector Cell

This is one of the phone's self tests which gives either a "pass" or "fail" result only. The phone transmits at several power levels and checks the ADC value of the power detector. The ADC value is measured first for a set of AGC values, then each AGC value is changed one at a time to make sure that the ADC changes as each AGC is changed individually.

Manual Verification:

Using Main Mode: Turn on the Cell CDMA TX with channel set to 384, and turn on IS95 modulation using CDMA control.

Using the PDM window, set:

TX_IF_AGC to – 100
TX_RF_AGC to –512
PA_AGC to +511.

Record the TX signal power from the antenna connector using a spectrum analyzer centered at 836.52 MHz. (The selftest measures the power detector reading instead, but at the present time this cannot be done with Phoenix; therefore, an easy way to check functionality without removing the covers is to check transmitted power. If the covers are removed, the voltage on PWR_OUT, at probing point 48 in Figure 1, can be measured). Transmitted power should be greater than 24 dBm. (PWR_OUT greater than 1.91v, which corresponds to the power detector ADC=700).

For each of the next three cases, TX power should be less than 24 dBm (less than 1.91v on PWR_OUT).

(1) TX_IF_AGC to – 80
TX_RF_AGC to -512,
PA_AGC to -512.

(2) TX_IF_AGC to +511,
TX_RF_AGC to -512,
PA_AGC to +511.

(3) TX_IF_AGC to -80
TX_RF_AGC to +511
PA_AGC to +511.

Troubleshooting: If there is a failure associated with only some of the cases above, check the AGC voltages and components of the associated PDMs as described in Tables 1 and 3. For problems with the IF or RF AGC, also check Robin and supporting components. For PA AGC problems, also check the PA and supporting components. If all of the above cases fail, troubleshoot the TX chain as described in the Probing Diagrams section. If all the output powers are passing, then perhaps the test is failing because the ADC voltage is wrong (which at this point we cannot read, so we are measuring the actual output power). This can be verified by measuring the voltage on the PWROUT probing point 48

in Figure 10. The limit is 1.6v. If the voltages are wrong, check the power detector at R821, R801, R804, L801, C805, R806, R805, C803, V801, C804, R803, and C807, and also Robin. If the voltages are correct and it still fails, check the UEM D200.

ST Robin VHFPLL Cell

This is one of the phone's self tests which gives either a "pass" or "fail" result only. The VHFPLL is inside the Robin IC. The phone checks the VHFPLL's lock detect bit. If this bit indicates that the PLL is unlocked, the test will fail.

Manual Verification: Turn on the Cell CDMA receiver to any channel and probe at L611 (probing point 11a in Figure 5) using an RF probe connected to a spectrum analyzer tuned to 346.2 MHz. If the PLL is locked, it will be stable in frequency. If it is unlocked, you may have to use a wide span to see it since it may be far off frequency.

Troubleshooting: First check that V601 and V602 have the proper orientation, then check C612, C613, R607, R605, C632, R606, C638, L611, C631, C630, C629, C637, R609, C618, and R613. Check power supplies to N601 (Robin), and ensure there is 2.7v on VR3 and VR6, and 1.8v on VIO (Table 12 and Figure 9). If no problems are found, replace Robin.

ST TX Detector PCS

This is one of the phone's self tests which gives either a "pass" or "fail" result only. The phone transmits at several power levels and checks the ADC value of the power detector. The ADC value is measured first for a set of AGC values, then each AGC value is changed one at a time to make sure that the ADC changes as each AGC is changed individually.

Manual Verification:

Using Main Mode: Turn on the PCS CDMA TX with channel set to 600. Turn on IS95 modulation using CDMA control.

Using the PDM window, set:

TX_IF_AGC to –150
TX_RF_AGC to –512
PA_AGC to +511

Record the TX signal power from the antenna connector using a spectrum analyzer centered at 1880 MHz. (The selftest measures the power detector reading instead, but at the present time this cannot be done with Phoenix; therefore, an easy way to check functionality without removing the covers is to check power out. If the covers are removed, the voltage on PWROUT, at probing point 48 in Figure 10, can be measured). Transmitted power for the above case should be greater than 24 dBm. (PWR_OUT greater than 1.09v, which corresponds to the power detector ADC=400).

For each of the next three cases, TX power should be less than 24 dBm (less than 1.09v on PWR_OUT):

(1) TX_IF_AGC to – 80

TX_RF_AGC to -512
PA_AGC to -512.

(2) TX_IF_AGC to +511
TX_RF_AGC to -512
PA_AGC to +511

(3) TX_IF_AGC to -80
TX_RF_AGC to +511
PA_AGC to +511

Troubleshooting: If there is a failure associated with only some of the cases above, check the AGC voltages and components of the associated PDMs as described in Tables 1 and 5. For problems with the IF or RF AGC, also check Robin and supporting components. For PA AGC problems, also check the PA and supporting components. If all of the above cases fail, troubleshoot the TX chain as described in the Probing Diagrams section. If all the output powers are passing, then perhaps the test is failing because the ADC voltage is wrong (which at this point we cannot read, so we are measuring the actual output power). This can be verified by measuring the voltage on the PWROUT, at probing point 48 in Figure 10. The limit is 1.09 v. If the voltages are wrong, then check the power detector at R821, R801, R804, L801, C805, R806, R805, C803, V801, C804, R803, and C807, and also Robin. If the voltages are correct and it still fails, check the UEM (D200).

ST Robin VHF PLL PCS

This is one of the phone's self tests which gives either a "pass" or "fail" result only. The VHFPLL is inside the Robin IC. The phone checks the VHFPLL's lock detect bit. If this bit indicates that the PLL is unlocked, the test will fail.

Manual Verification: Turn on the PCS CDMA receiver to any channel and probe at L611 (probing point 11a in Figure 5) using an RF probe connected to a spectrum analyzer tuned to 416.2 MHz. If the PLL is locked, it will be stable in frequency. If it is unlocked, you may have to use a wide span so see it since it may be far off frequency.

Troubleshooting: First check that V610 and V602 have the proper orientation, then check C612, C613, R607, R605, C632, R606, C638, L611, C631, C630, C629, C637, R609, C618, and R613. Check power supplies to N601 (Robin) and ensure there is 2.7v on VR3 and VR6, and 1.8v on VIO (Table 12 and Figure 9). If no problems are found, replace Robin.

SN Cell PA Temp

This is one of the phone's self tunings, which reads the ADC voltage of a thermistor R808, and checks to make sure the phone is at room temperature. The reason for this is that we don't want to tune a phone while it's hot or cold.

The phone reports the ADC voltage value of the thermistor, and it should be within the limits.

Manual Verification: Ensure the phone is cool by letting it cool down for several minutes, and retest, keeping in mind that if there is a short circuit on the board, then it will get

hot very quickly.

Troubleshooting: If the phone was recently transmitting in Cell band at full power for an extended period of time, it is probably hot for that reason. Let it cool down for a few minutes, then try again. If it still fails, there may either be a short on the board or else a problem with the PA Temp circuitry. To check PA Temp circuitry, check R808, C232, R202, and D200. If a short is suspected, check the cell PA first. If an infrared camera is available, this is one of the easiest methods to detect a short.

SN Cell RX BB Filter

This is one of the phone's self tunings, which tunes the lowpass filter in the Batman IC N701, in cell CDMA mode.

This self tuning returns one of the filters tuned parameters, which should be within the limits.

Manual Verification: Use RF Tuning window in Phoenix, set mode to "self tune" and choose this tuning.

Troubleshooting: Check Batman (N701) and supporting components.

SN Cell RX DC Offset I (or Q)

This is one of the phone's self tunings, which measures and adjusts the cell band CDMA receiver DC offsets until they are within the limits.

The DC offset is returned for I (or Q).

Manual Verification: Use RF Tuning window in Phoenix, set mode to "self tune" and choose this tuning.

Troubleshooting: Check Batman (N701) and supporting components.

SN AMPS RX BB Filter

This is one of the phone's self tunings, which tunes the lowpass filter in the Batman IC (N701) in AMPS mode.

This self tuning returns one of the filters tuned parameters, which should be within the limits.

Manual Verification: Use RF Tuning window in Phoenix, set mode to "self tune" and choose this tuning.

Troubleshooting: Check Batman (N701) and supporting components.

SN AMPS RX DC Offset I (or Q)

This is one of the phone's self tunings which measures and adjusts the cell band AMPS receiver DC offsets until they are within the limits.

The DC offset is returned for I (or Q).

Manual Verification: Use RF Tuning window in Phoenix, set mode to "self tune" and choose this tuning.

Troubleshooting: Check Batman (N701) and supporting components.

Test TX Start up Current

This test turns on the AMPS transmitter (PCS transmitter for PCS-only phones) and measures current of the whole phone, which can detect some assembly errors.

Manual Verification: Set the phone to local mode and turn on the AMPS transmitter. Set the PDM values as listed in Table 1 for AMPS Power Level 5 (for PCS, set output power to +12 dBm). Read the phone's current on the power supply and check to see that it is within the limits. If the power supply does not display current draw, use a current meter in series with the phone. If the phone powers down when the mode is set, it may be that the phone is drawing more current than the current limit setting on the power supply.

Troubleshooting: If current is very high, there may be a short circuit on the phone caused by a solder bridge, a failed component that is internally shorted, a component placed with the wrong rotation (which shorts two nodes that shouldn't be), or some other reason. Short circuits can be difficult to find, but one of the easiest methods is to use a thermal camera and look for hot spots that are not normally hot, and look for the hottest spots. A visual inspection can find solder bridges or wrong component rotations. A failed component can be found by functional tests of the phone's sub-blocks.

Test TX Start up Amplitude

This test turns on the AMPS transmitter (PCS transmitter in PCS-only phones) and checks for the presence of a TX signal with an amplitude within a specified range. A wide range is allowed since the transmitter is not yet tuned.

Manual Verification: Set the phone to local mode and turn on the AMPS transmitter set to channel 384. Set the AGC PDM values as in test 17. Look for an output signal at 836.52 MHz with an amplitude within the limits. The frequency of the signal may not be accurate since the VCTCXO has not yet been tuned.

Troubleshooting: Check proper placement, rotation, and soldering of the components in the TX chain, as shown in Figure 5. Check for the presence of LO tones as listed in Table 2. Check for presence of a TX signal at each point in the TX chain, probing according to Table 2.

TN VCTCXO Frequency

The purpose of this tuning is to determine what the AFC DAC value needs to be in order to center the VCTCXO frequency. The PCS transmitter is turned on and no TX baseband modulation is provided. The carrier is then centered in frequency. This is done to the carrier after it has been mixed up to 1880 MHz, since it's easier to measure the tolerance of 1 ppm at 1880 MHz than it is at 19.2 MHz. Additionally the tone at 1880 MHz can be

measured without taking the phone apart.

The result is a PDM value for the AFC DAC, which must be within +/- 150, which corresponds to 2.2 v on the VCTCXO control pin (pin 1) and the carrier centered within +/- 100Hz. The VCTCXO must be able to be centered within a certain voltage range in order to allow for aging of the crystal (the centering voltage slowly drifts over time and the phone will eventually run out of voltage range if it begins too close to the edge of the range).

Manual Verification: Using the RF Main Mode window in Phoenix, turn on the PCS transmitter, and set it to channel 600. Do not add any modulation.

Using the RF Tuning window, set mode=RF Tuning and choose this tuning. Look for a transmitted tone on the spectrum analyzer at 1880 MHz. If no tone is present, proceed to *Troubleshooting* section.

Center the carrier to within +/- 100 Hz of 1880 MHz. (If sidetones are present, be careful to center the carrier and not one of the sidetones, which will probably have a higher amplitude than the carrier.) The values you enter in the "values" edit box are the AFC values which control the VCTCXO frequency. Start with a value of 0, then adjust until it is centered, staying within the limits.

Troubleshooting:

1) If there is no tone, probe pin 3 of G501 for a tone at 19.2 MHz. If this is not present check power supplies, particularly ensure 2.7v on VCTCXO Vcc pin, pin 4 of G501. Also check the control pin, pin 1 of G501, for a voltage between 0.4 and 2.7 v. If the voltages are correct, and soldering of all G501 terminals is correct, replace G501. If 19.2 MHz tone is present but tone at 1880 MHz is not, troubleshoot PCS TX chain as described in the Probing Diagrams section.

2) If the carrier is present but the PDM needed to center it is outside of the +/- 150 range, or if it cannot be centered, there is a hardware problem.

3) In the following procedure, performing frequency centering on the RF carrier at 1880 MHz will detect frequency errors due to the VCTCXO and supporting hardware, which will be the majority of the problems, but will not detect frequency errors due to the hardware that mixes the VCTCXO tone at 19.2 MHz up to 1880 MHz. In order to troubleshoot this hardware also, frequency centering should be performed on the 19.2 MHz tone to +/- 19.2 Hz on pin 3 of G501 using a frequency counter, then the VHF and UHF LOs should be checked. Since this will be time-consuming and will probably only account for a small percentage of the failures, it is not recommended unless the situation justifies the time spent. The VHF LO is inside the Robin IC (N601) and troubleshooting of the cell UHF LO is according to Table 2.

4) If the carrier can be centered but the PDM is out of range, check the control voltage on pin 1 of G501. If it is 2.2v, (and pin 4 is at 2.7v, and pin 2 at 0v), then the VCTCXO (G501) is working correctly but the circuit that delivers the control voltage is not. Check

soldering of all G501 terminals; also check R510, R511, C503, and D200. If the control voltage on pin 1 of G501 is not 2.2v, but the carrier is centered, then there is a problem with the VCTCXO G501. If there is 2.7v on pin 4 and the soldering is correct, then replace G501.

5) If the carrier cannot be centered, check to see if you can adjust to 2.2v on pin 1 of G501. If you can, within the PDM range of +/- 150, then the circuitry that delivers the voltage is working correctly, and the VCTCXO has a problem. Troubleshoot it as described in the previous section. If you cannot adjust to 2.2v within the accepted range, then the AFC circuitry has a problem. Troubleshoot it as described in the previous section.

6) In cases where there is a fault with both the AFC circuitry and the VCTCXO, several combinations of the previously described conditions are possible. Start by ensuring 2.2v on pin 1 of G501 using a PDM within the range +/- 150, then center the tone.

TN TX DC Offset Reference Power

The DC offset voltages on the I and Q inputs to the modulator are adjusted for minimal carrier feedthrough (maximum carrier suppression). Initially the DC offsets are set to a nominal value, and the power of a tone offset in frequency 20 kHz from the carrier is measured in dBm and recorded as a reference (in this tuning). Then in the next tuning, the carrier suppression (delta between center tone and tone that is offset 20 kHz) is measured. If it passes, it is reported in that tuning. If not, the DC offsets are adjusted until it passes, and the passing value is reported.

The reported result is the power in dBm of the tone that is offset 20 kHz from the carrier, as measured on the antenna connector, with the nominal DC offsets applied.

Manual Verification:

In Phoenix, use the RF Main Mode window to set the AMPS transmitter to channel 384.

Using the RF Tuning window, set the I and Q DC offsets to 0,0 by entering 0,0 in the "values" edit box.

Center the transmit signal on the spectrum analyzer, set the span to 100 kHz. Lower the bandwidth so that the two sidetones can be differentiated from the carrier. Measure the amplitude of the sidetone at 20 kHz above the carrier. The amplitude of the sidetone will probably be higher than that of the carrier; amplitude should be within the test limits.

Troubleshooting: If the carrier is not present, troubleshoot the cell TX chain using the "things to check" list and probing tables/diagrams. If the two tones offset at 20 kHz are not present on the TX signal, check to see if they are on Robin output at L613 at 836.52 MHz + 20 kHz. If not, there is likely a problem with N601 (Robin). Ensure power supplies to Robin (VR2, VR3, VR6, and VIO) are correct. Check components around Robin. If still failing, replace Robin.

TN TX DC Offset Carrier Suppression

See previous tuning. This step reports the delta between the reference at 836.52 MHz

+ 20 kHz, and the minimum carrier level at 836.52 MHz.

The result is a delta in dB between the reference at 836.52 MHz + 20 kHz, and the minimum carrier level at 836.52 MHz, found by adjusting the DC offsets for I and Q individually. The delta should be at least 35 dB.

Manual Verification: Set up the phone as in the previous test, and record the reference power of the offset tone. Measure the delta between the center and offset tones. If the delta is 35 dB or greater, the phone passes. If less than 35 dB, vary the "I" DC offset on the "values" line in the RF Tuning window, using the below listed values until the minimum carrier maximum delta is found. Leave Q at 0. On the "values" line, you enter "I,Q". The values, in decimal, are:

-560

-504

-448

-392

-336

-280

-224

-168

-112

-56

0

56

112

168

224

280

336

392

448

504

560

If the minimum is 35 dB or greater, the phone passes. If the minimum is less than 35 dB, then vary Q in the same manner as I using the above values, holding I constant at the minimum value determined above, until the delta is at least 35 dB.

Troubleshooting: Check N601 (Robin), D200 (UEM), and associated components.

TN TX IF AGC Cell Po (0) [or (1), (2), (3), or (4)]

The IF gain curve is characterized by varying the TX_IF_AGC and measuring the transmit power. This is only done once (in cell CDMA mode) since the same circuitry is used for both cell and pcs.

The results are TX power readings in dBm of the transmitted signal corresponding to given PDM settings of the Cell TX IF AGC.

Manual Verification:

Set the phone in local mode, then program it to Cell CDMA RX/TX mode on channel 384. Set modulation to IS95 voice.

Set the Cell PA PDM to +218 decimal and the TX RF AGC to –512 decimal using the sliders in the PDM window under the RF menu.

Change the TX_IF_AGC to the settings in the following table, and measure the TX power levels, checking to see that they are within the specified range.

PDM for TX IF AGC	Acceptable range for output power (in dBm)
(a) +300 decimal	check tuning results file for limits
(b) + 150	
(c) 0	

Change the TX_RF_AGC PDM to +511. Leave the TX_IF_AGC at 0 and the PA_AGC at +218. Measure the output power. Subtract this power from the power measured in (c) in the table above. This is the RF_AGC gain delta.

Leave the PA_AGC and TX_RF_AGC values as is, then enter the values listed below for the TX_IF_AGC. Measure the output power, then add to each the RF_AGC gain delta calculated above. Check that these sums are within the listed ranges.

PDM for TX IF AGC	Acceptable range for sum:[output power +- RF_AGC gain delta] in dBm
-200	check tuning results file for limits
-400	

Troubleshooting: Check Robin (N801) and supporting components. Also check D400, which generates the PDM signals. Check AGC PDM voltages according to Tables 1 and 3. Troubleshoot the rest of the transmitter chain if necessary as described in Table 2.

TN PA Gain Cal Cell Po (0) [or, (1), (2), (3), (4), or (5)]

These tunings model the cell PA gain curve by setting the PA AGC PDM to several values and measuring output power. First, the TX PA AGC and the TX RF AGC are set to (approximately) their maximum used values (not the maximum possible values, but the maximum of the range over which they are used). Then the TX IF AGC is set so that the transmit power on the antenna connector is approximately +11 dBm (this power is reported in the next tuning). Then, six PDM values are written to the PA AGC and the output power is measured for each. These values are reported in this tuning. The software then performs curve fitting to interpolate between the measured data points.

The result is the transmitted power in dBm for each of the six PA AGC PDM settings (results labeled 0 through 5).

Manual Verification:

Turn on the cell CDMA transmitter in Phoenix using the RF Main Mode window, and set it to channel 384. Set modulation to IS95 voice.

Set the TX_IF_AGC PDM to 0 decimal.

Set the PA AGC PDM to +218 decimal.

Set the TX RF AGC PDM to –512 decimal.

Adjust the TX IF AGC PDM so that the transmitted tone at 836.52 MHz measures +11 dBm +/- 0.5 dB on the antenna connector, using a spectrum analyzer (use 0 as a starting point). Make a note of this value as it is needed in other Troubleshooting sections.

Write the PDM values listed below into the PA AGC and record the output power. Check to see if the output power is within the ranges listed on the tuning result printout. (Limits are not provided in this document as they may change.)

PDM for PA AGC	Acceptable range for output power (in dBm)
+218 decimal	limit range for Po(5)
-12	limit range for Po(4)
-202	limit range for Po(3)
-268	limit range for Po(2)
-329	limit range for Po(1)

Troubleshooting: If the power readings are low, check the AGC voltages as in Tables 1 and 3. You can also probe on the PA input as in Table 2 to find out if the power level is low going into the PA, or if the power level is correct going into the PA but the PA gain is too low. If the power level going into the PA is too low, probe the TX chain at all the

other points prior to the PA listed in the table to see where the gain is lacking. When that point is identified, check the soldering of all related components, and replace components until the fault is found. If the power on the PA input is not low and the PA AGC voltage is correct, similarly probe the power at all points after the PA to find the fault, being extremely careful not to short the probing point to ground because this will instantly destroy the PA. Visually check soldering first, and probe on PA output as a last resort.

TX TX IF 11 dBm Set CELL Po

See previous tuning. This is the part of the previous tuning when the TX IF AGC is adjusted so that the output power is +11 dBm

The result is a power in dBm. A perfect result would be +11.00 dBm.

Manual Verification: See previous tuning.

Troubleshooting: See previous tuning.

TN TX RF AGC Cell Po (0) [or (1), or (2)]

This tuning characterizes the RF AGC curve by entering PDM values to the RF AGC and measuring the output power.

The results are TX power readings in dBm of the transmitted signal measured for each of the listed PDM settings of the Cell TX RF AGC.

Manual Verification:

Turn on the cell CDMA transmitter in Phoenix using the RF Main Mode window, and set it to channel 384. Set modulation to IS95 voice.

Set the Cell PA PDM to –329.

Set the TX_IF_AGC to the value determined in tuning TX TX IF 11 dBm Set CELL Po (above section) to give +11 dBm on the output.

Change the TX RF AGC to the settings in the following table, and measure the TX power levels, checking to see that they are within the specified range.

PDM for TX RF AGC	Acceptable range for output power (in dBm)
-512 decimal	check limits in tuning results file
-67 decimal	
-22 decimal	
+418	
+511	

Troubleshooting: Check Robin (N801) according to Tables 1, 2, and 3. Also check D400, which generates the PDM signals. Check AGC PDM voltages according to Table 1. Troubleshoot the rest of the cell transmitter, if needed, according to Table 2.

TN TX Gain Comp Cell (or PCS) Po MD (or LO, LM, ML, MH, HM, or HI)

Description for this and next tuning: This tuning ensures that the value of TxdBCtr correctly corresponds to the absolute TX output power. On the midchannel, with TxdBCtr set to a specified value, G_Offset is adjusted so that the output power is –8 dBm, and the value of G-Offset is recorded (which is an absolute value) in the next tuning. The output power in dBm is recorded in this tuning. After this is done on the midchannel, the channel is changed to each of the other channels, and output power is reported. (G_offset is not adjusted on the other channels as it was on the center channel — just the output power is recorded).

The result is the transmitted power in dBm, which should be –8.0 dBm +/- 0.5 dB on the center channel.

Manual Verification:

Set the phone to local mode and program it to Cellular (or PCS) CDMA RX/TX mode on channel 384 (or 600 for PCS) using the Main Mode window.

Using the Phoenix RF Tuning window, choose "mode" = RF Tuning, and choose this test. Adjust G_Offset in the "values" dialog box line until the TX output power (measured on the RF connector with a spectrum analyzer) is equal to –8.0 dBm +/- 0.5 dB. Use the G_Offset limit range as a guide to which values to enter.

Once this is done on the center channel, change to each of the other channels, and record the power. Do not adjust G_Offset on the other channels — just record the power. It should be within the limits listed in the tuning results file.

Channel	Cell	PCS
Low	991	25
LowMid	107	200
MidLow	245	400
Mid	384	600
MidHigh	512	800
HighMid	660	1000
High	799	1199 (1199 not a voice channel, but used in tuning

Troubleshooting: If –8 dBm cannot be attained, troubleshoot Cell TX as described in the beginning of this chapter.

TN G_Offset Cell MD

See description of previous tuning. This step reports G_Offset.

The result is the value of G_Offset which gives –8.0 dBm transmitted power.

Manual Verification: See previous tuning. The value of G_Offset needs to be -8 dBm on the center channel.

Troubleshooting: If G_Offset is not within the limits, troubleshoot the Cell TX as described in the beginning of this chapter.

TN AMPS PL2 Po Mid (or Low, LowMid, MidLow, MidHigh, HighMid, or High)

This procedure tunes the AMPS transmit Power Level 0 on seven channels by adjusting TxdBCtr. The channels are: Low= 991, LowMid= 107, MidLow= 245, Mid= 384, MidHigh= 521, HighMid= 660, High=799. The algorithm then interpolates between the measured points for frequency compensation.

The result is measured transmit power in dBm for power level 0 on each of the seven channels.

Manual Verification: Set the phone to local mode and turn on the AMPS transmitter to the channel which failed.

Using the Phoenix "RF Tuning" window, set "mode" = RF Tuning, and select this test. Adjust TxdBCtr in the "values" dialog box until the output power is within the limits (adjusting for cable loss).

Troubleshooting: Troubleshoot the cell transmitter as described in the Probing/Trouble-shooting Tables and Diagrams section, setting the TX AGC values to those listed for

Power Level 0 in Table 1.

TN AMPS PL3 (or 4, 5, 6, or 7) Po

This procedure tunes power levels 3 through 7, all on the center channel. Power level 0 was tuned in the previous test. (Power levels 0, 1, and 2 are the same for this phone.)

The result is measured transmit power in dBm for power levels 3 through 7 on channel 384.

Manual Verification: Use the same procedure as in previous tuning, but on channel 384. Note that the limits are different from the previous tuning.

Troubleshooting: Troubleshoot the cell transmitter as described in the beginning of this chapter, setting the AGCs as in Table 1 for the power level that failed.

TN PA Gain Cal PCS Po (0) [or (1), (2), (3), (4), or (5)]

This tuning characterizes the PCS PA gain curve, and the method is the same as the Cell PA Gain Cal tuning described in TN PA Gain Cal Cell Po (0).

The result is the transmitted power in dBm for each of the six PA AGC PDM settings (results labeled 0 through 5).

Manual Verification: This is the same as described in TN PA Gain Cal Cell Po (0), except the phone is set to transmit in PCS mode on channel 600. The transmit frequency is 1880 MHz.

Troubleshooting: Troubleshoot in the same manner as described in TN PA Gain Cal Cell Po (0) for cell band, using the PCS band tables in the Probing/Troubleshooting Tables and Diagrams section: Tables 1, 4, and 5.

TN TX IF 11 dBm Set PCS Po

See previous tuning. This is the part of the previous tuning when the TX IF AGC is adjusted so that the output power is +11 dBm

The result is a power in dBm. A perfect result would be +11.00 dBm.

Manual Verification: See previous tuning.

Troubleshooting: See previous tuning.

TN TX RF AGC PCS Po (0) [or (1), or (2)]

This tuning characterizes the PCS TX_RF_AGC, and the method is the same as in the SN Cell PA Temp section, except that the phone is set up to transmit in PCS mode on channel 600. The transmit frequency is 1880 MHz

The results are TX power readings in dBm of the transmitted signal corresponding to PDM settings of the PCS TX RF AGC.

Manual Verification: Use the same method as for the cell band described in the TN TX RF AGC Cell Po (0) section, but set the phone to transmit in PCS on channel 600.

Troubleshooting: Check Robin (N801) according to Tables 1, 4, and 5. Also check D400, which generates the PDM signals.

TN TX Limiting Po Cell (or PCS) IS95, Low channel (or LowMid, MidLow, Mid, MidHigh, HighMid, or High channel)

This tuning provides an upper limit on the transmit power while in Cell (or PCS) IS95 mode. This ensures that the phone never violates the Specific Absorption Ratio (SAR) limit, which is a health and safety specification that limits the amount of radiation near the user's head. The phone is set to transmit and TxdBCtr is adjusted for the maximum transmit power.

The result is a power level in dBm, which is the maximum allowed. This is done on each of the seven channels.

Manual Verification: Using Phoenix, set the phone to local mode, then turn on the Cell (or PCS) transmitter set to each of the channels in the list below.

Using the RF Tuning window, adjust TxdBCtr in the "values" dialog box until the TX power — measured on the RF connector with a spectrum analyzer — is within the limits on each of the following channels.

Channel	Cell	PCS
Low	991	25
LowMid	107	200
MidLow	245	400
Mid	384	600
MidHigh	512	800
HighMid	660	1000
High	799	1199 (1199 not a voice channel, but used in tuning)

Troubleshooting: If the maximum cannot be reached, either a component in the transmitter has too much loss, or not enough gain. Troubleshoot the Cell (PCS) transmitter, with the phone set to the same channel as the failed channel.

TN TX Limiting Cell (or PCS) CDMA2000: Po

Same as previous tuning, except that CDMA2000 (C2K) modulation is used instead of IS95.

Explanation of Result: See previous tuning.

Manual Verification: Same as previous tuning, except choose the CDMA 2000 tuning in the RF Tuning window.

Troubleshooting: Same as previous tuning.

TS ACPR PCS- Low (High)

Adjacent Channel Power Ratio (ACPR) is a measure of band power in the adjacent channel as compared to the tuned channel, so it is a power delta in dB. Band power is measured at the center tuned frequency and also at an offset lower (higher) than the center frequency, and the difference is ACPR. For this test, the offset is –1.25 MHz (+1.25 MHz). Band power is integrated power over a frequency band, rather than at a single frequency. The bandwidth for the measurement centered at the tuned frequency is the bandwidth of the signal, which for IS95 is 1.23 MHz. The bandwidth used at the offsets is 30 kHz.

Result is ACPR (a power delta) in dB.

Manual Verification: Set the phone in local mode, and turn on the PCS transmitter set to channel 600. Use the TX Limiting function in the RF Tuning window to set the transmit power to the maximum value (within the limits for the "TX Limiting" tuning).

Observe the TX signal on the spectrum analyzer. If the spectrum analyzer being used has a CDMA personality card, ACPR can be read directly off the screen. If not, then set the bandwidth to 30 kHz, and set the averaging on. Center the marker at 1880 MHz and note the power in dBm. Use the offset marker to measure the power at an offset of -1.25 MHz (+1.25 MHz). Subtract the two power readings, then add 16 dB to compensate for the fact that the power at the center frequency was measured with a 30 kHz bandwidth rather than 1.23 MHz. Figures 3 and 4 below show examples of good and bad ACPR.

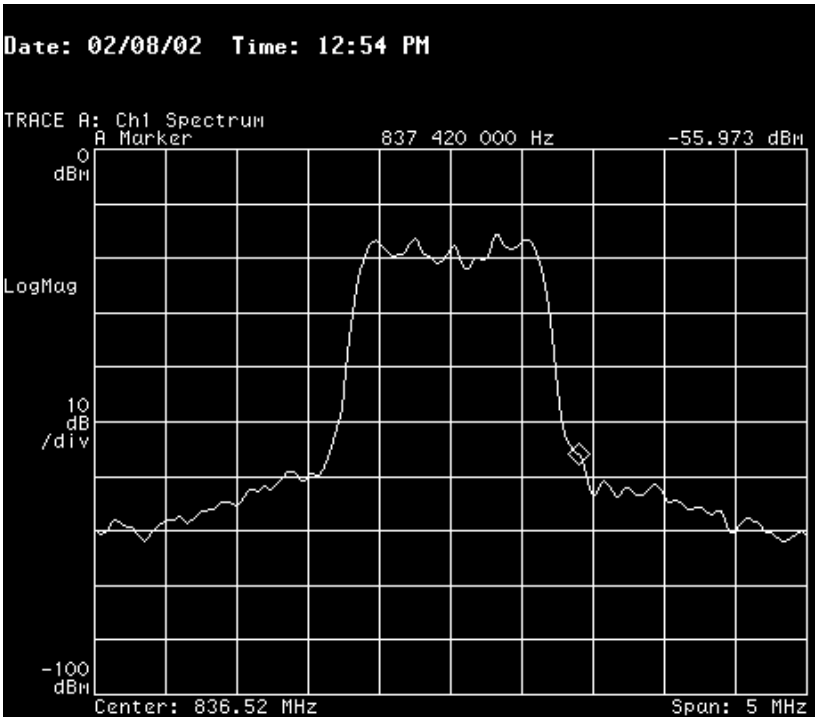

Figure 3: Good ACPR (analyzer screenshot)

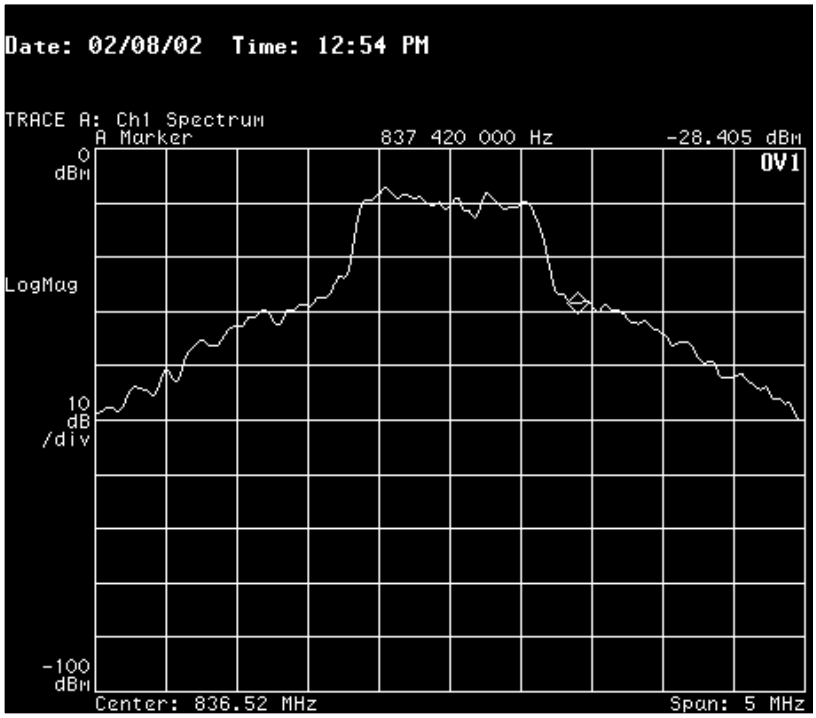

Figure 4: Bad ACPR (analyzer screenshot)

Troubleshooting: If one or more of the AGC values needs a value much higher than normal to achieve maximum power, that would indicate that a component in the chain has less gain (or more loss) than it should, and another component that is compensating for that could be saturating. Use the AGC information as a guide to troubleshoot the PCS chain as described in the Probing/Troubleshooting Tables and Diagrams section, being careful to check all decoupling capacitors (C614, C615, C605, C603, C602, C624, C621, C651, C611, C634, C635, C608, C650, C817, C808, C814, C809, C813). Severely degraded ACPR is detectable just by looking at the shape of the CDMA curve (see figure above); therefore, you can also probe each point in the TX chain to see if ACPR becomes degraded at one point.

TN PA Detector PCS Po (0) [or (1), (2), (3), (4), (5), (6), or (7)]

This tuning determines the output voltage of the TX power detector as a function of transmitted RF power.

The result is the measured transmitted power in dBm.

Manual Verification: Find out the value of TxdBCtr which sets TX Limiting in IS95 mode on channel 600 in PCS by performing the manual tuning of the TN TX Limiting Po Cell (or PCS) IS95 section (TX Limiting). Next, choose the PA Detector PCS tuning in the RF Tuning window. Enter the values of TxdBCtr that are listed in the following table into the "values" dialog box, and ensure that the transmitted power is within the limits.

TxdB Ctr Value	Transmitted power (in dBm)
(TxdBCtr for TX limiting) + 350	Check tuning results file for limits
(TxdBCtr for TX limiting) - 500	
(TxdBCtr for TX limiting) - 1000	
(TxdBCtr for TX limiting) - 1500	
(TxdBCtr for TX limiting) - 3200	
(TxdBCtr for TX limiting) - 4200	

Troubleshooting: If transmitted power levels can not be attained, check PCS TX as described at the beginning of this chapter.

TS ACPR Cell - Low

See description for PCS ACPR. In cell band, however, the offset is –0.9 MHz (+ 0.9 MHz).

See TN TX Limiting Po Cell (or PCS) IS 95 section for an explanation of results.

Manual Verification: Set up the measurement as described in the TN TX Limiting Po Cell (or PCS) section, but turning on the Cell transmitter to channel 384. Likewise, use the TxdBCtr value for Cell TX Limiting on channel 384 in IS95 mode. Measure at the center frequency of 836.52 MHz, and the offset of +/- 0.9 MHz.

Troubleshooting: Refer to the TN TX Limiting Po Cell (or PCS) IS95 section, and also the Cell TX troubleshooting guide of the Probing/Troubleshooting Tables and Diagrams section. Cell band TX decoupling capacitors are C653, C633, C649, C648, C619, C817, C810, and C811.

TN RX IF AGC RXdBCtr (0) [or (1) or (2)]

This tuning calibrates the RX IF AGC curve since the output power of the IF part of the Batman IC is not a linear function of RX_IF_AGC. The tuner injects three known signal power levels into the phone's receiver, and for each one the phone's AGC algorithm adjusts the RX_IF_AGC to get the same amplitude at the output of Batman, although different amplitudes are going in. From these three points, curve fitting is used to interpolate between measurement points.

The result is a value of RxdBCtr (which corresponds to a value of RX_IF_AGC) for each of three CW input powers injected into the receiver:

Trimode	PCS only
-87.5 dBm	-89 dBm
-57 dBm	-61 dBm

Trimode	PCS only
-18 dBm	-22 dBm

Manual Verification: With the phone in local mode, use the Main Mode window to turn on the AMPS receiver set to channel 384. Using the RF Tuning window, perform the manual tuning three times, each time injecting the CW signal at the amplitudes listed above — one amplitude per tuning. Each time, record RxdBCtr, which is returned by Phoenix during the manual tuning. For the manual tuning, use the RF Tuning window with "mode"=RF Tuning, and choose the appropriate tuning name. Ensure that the resulting value of RxdBCtr is within the limits in the tuning results file.

Troubleshooting: While injecting a signal into the receiver, check the values of RSSI and RX_IF_AGC PDM value and, if needed, voltage. RSSI should be within +/- 2 dB of the actual power in dBm on the RF connector. Table 3a lists limits and typical values. The AGC will try to keep the same amplitude on Batman output; therefore, if the AGC value is larger than normal, then the AGC is compensating for loss in the chain prior to the variable gain amplifier.

After checking RSSI and AGC value, if it is still necessary to probe to pinpoint the source of the error, use the AMPS probing tables.

TN LNA AMPS (or Cell or PCS) LowGain (or HighGain) LO (or LM, ML, MD, MH, HM, HI)

This tuning records RxdBCtr (which is automatically adjusted to produce the same amplitude on the receiver output no matter what the input is) for the receiver with the LNA in highgain mode, and again with the LNA in lowgain mode. For AMPS, this is done only on the center channel, but for Cell and PCS it is done over several channels.

The result is a value of RxdBCtr.

Manual Verification: Using Phoenix, choose this tuning in the RF Tuning window. Inject a CW signal that is 10 kHz offset from the center frequency of the channel that is being tuned. For AMPS, set the amplitude to –65 dBm, for Cell and PCS set it to –95 dBm. Record RxdBCtr, which is returned from Phoenix in the lowest field in the RF Tuning window.

Troubleshooting: Check Alfred and supporting components.

Final UI test: Rho

Rho is a measure of CDMA transmit signal quality which encompasses other transmitter indicators such as phase error and magnitude error. Rho is measured with the phone in a phonecall, and is read directly from the call box. Rho is measured with sector power= 75 dBm. If Rho fails, first check the signal purity of the LOs. Check synthesizer components and power supply decoupling.

Final UI test: Frame Error Rate (FER)

This measurement — also made in a phone call — measures the frame errors of the receiver in CDMA mode. A low amplitude signal (typically at receiver sensitivity level of –104.0 dBm) is injected into the receiver, and the FER is recorded. FER is measured in percentage, and 0.5 % or lower is passing (w/ 95% confidence). Failures are most often caused by excess loss/insufficient gain in the receiver chain, (and sometimes by excess noise in the receiver). Check for correct signal levels and AGC values/voltages as described in the Probing/Troubleshooting Tables and Diagrams section.

Final UI test: SINAD

Signal-to-Noise-and-Distortion (SINAD) is similar to a sensitivity/FER measurement for CDMA, but is used in AMPS.

A low-level signal (typically at a sensitivity level of -116.0 dBm) is injected into the receiver, and SINAD is read off the call box, with 12 dB as the passing limit.

Probing/Troubleshooting Tables and Diagrams

When measuring CDMA transmit signals, if the spectrum analyzer does not have a CDMA personality card, then the CDMA signal power can be approximated by setting the Resolution Bandwidth to 1 MHz and using the marker. This is because CDMA signal power is measured by integrating power over a 1.23 MHz bandwidth, and the marker measures power at only one frequency.

In most cases, probing is done in local mode (*i.e.,* not in a call). Situations may arise whereby the troubleshooter may need to probe while in a call; however, in some cases probing may disturb the circuit so that the call drops.

Although the tables list power levels for many combinations of AGC values, it is generally only necessary to check one combination. The extra information is provided in case it may be useful in an unexpected situation. Likewise, although probing points and signal level information are given for each point in the receiver and transmitter chains, the troubleshooter is not expected to probe each point on every phone, only the suspected trouble spots.

Absolute power measurements were made with an Agilent (HP) 85024A active high impedance probe. Other probes can be used (but should be high impedance so that the measurement does not load the circuit) but may very well have a different gain, therefore adjust the absolute measurements accordingly. Also, adjust measurements if using a probe attenuator.

Where a range is given for loss, typically the higher loss occurs at the band edges.

Power depends on the impedance of the circuit. For example, if a filter has a nominal loss of 5 dB, then straightforward probing on the input and output, then subtracting, might not result in 5 dB since the input impedance might be different from the output impedance. However, after mathematically adjusting the power on either the input or output to compensate for the difference in impedance, 5 dB is then calculated. Most compo-

nents in the RF section have the same input and output impedance (50 ohms), but where this is not the case, absolute power is noted in the tables in dBm, rather than loss or gain in dB.

When testing the CDMA receiver, it is easier to inject a CW tone into the receiver. The gains and losses will be the same for a CW signal as for CDMA.

Transmitter Probing

Table 1: Transmit Output Powers and Associated AGC PDM values and voltages

channel 384 (Cell) or 600 PCS							
AMPS							
TX RF AGC		TX IF AGC		Probed RF power on Balun Out	PA AGC		RF power on RF connector
PDM value	voltage	PDM value	voltage		PDM value	voltage	
typical	v	typical	v	dBm	typical	v	dBm
-409	0.17	-110	0.68	-11.2 +/- 3 dB	-19	0.84	26.5 (PLO)
-409	0.17	-92	0.71	-13.2 +/- 3 dB	-123	0.66	25.0 (PL3)
-409	0.17	-76	0.74	-15.4 +/- 3 dB	-310	0.34	21.0 (PL4)
-249	0.44	-66	0.77	-19.4 +/- 3 dB	-330	0.30	17.0 (PL5)
-104	0.70	-56	0.78	-22.4 +/- 3 dB	-330	0.30	13.5 (PL6)
37	0.95	-48	0.79	-27.9 +/- 3 dB	-330	0.30	9.0 (PL7)
CELL CDMA							
-403	0.17	-115	0.678	-14 +/- 3 dB	220	1.27	25
-403	0.17	100	1.064	-38 +/- 3 dB	-270	0.40	-2
200	1.23	100	1.064	-56 +/- 3 dB	-331	0.29	-23
450	1.68	105	1.07	-70 +/- 3 dB	-331	0.29	-39
511	1.78	170	1.19	-80 +/- 3 dB	-331	0.29	-50
PCS							
-428	0.13	-220	0.495	-17 +/- 3 dB	220	1.27	24
-235	0.46	-28	0.832	-47 +/- 3 dB	-324	0.31	-3
290	1.39	-28	0.832	-66 +/- 3 dB	-324	0.31	-23
511	1.78	-20	0.846	-76 +/- 3 dB	-324	0.31	-38
511	1.78	110	1.082	+/- 3 dB	-324	0.31	-50

IMPORTANT NOTE: AGC PDM values will change (sometimes drastically) as the phone warms up. The table above lists PDM values for when the phone is first turned on. After 10 minutes at full power, PDM values will be different.

Table 2: RF/Analog Probing for Cell/AMPS Transmitter

Probing Point	Probing location on board	Probed absolute power (dBm) or gain/loss (dB), or voltage (v)	Where to start checking if RF power not correct (soldering, shorts, DC power applied if active, correct voltage of DC signals, otherwise replace)
Robin (N601) out = Balun (T604) in	2a and 2b, Figure 5	easiest to probe on balun output as per Table 1. Nominal loss through balun=1dB, but will appear as 3-4 dB gain due to impedance difference. On Robin output, you may see amplitude imbalance between two sides of probing point 2 due to impedance differences (less in cell).	N601 (ensure VREFRF02 is 1.35v as in Table 2. Check AGC voltages/ PDMs as in Table 2), T604, L604, L603, C640, C642, C907, N603 (including check for 3.6v on pin5), D400 (including AGC voltage check in Table 2)
Balun (T604) out = Tomcat (N603) in	3, Figure 5	See Table 1	T604, C640, C642, L603, L604, N601, C907, N603 (including check for 3.6v (Vbat) on pin 5 and 2.6v on pin 4)
Tomcat (N603) out = TX SAW filter (Z604) in	4, Figure 5	Gain = 12-16 dB through Tomcat	N603 (also ensure 3.6v on pin 5 and PD_CELL high as in Table 2), N601, C649, C639, Z604, N801 (Vbat)
TX SAW filter (Z604) out = cell PA (N801) in	5, Figure 5	Loss = 2-3 dB through SAW	Z604, N603, N801 (Vbat)
Cell PA (N801) out = cell isolator (Z802) in	6, Figure 5. Probing here not recommended unless necessary; best to measure on RF connector	PA has variable gain, see Table 1. Best to measure on RF connector.	N801 (including: check 3.6v on Vbat), Z802, R805, R801, L801), D400 (including AGC voltage check in Table 1), N601 (since Iref, also check PA_AGC as in Table 1)
Cell isolator (Z802) out = cell duplexer (Z803) in	7, Figure 5. Probing here not recommended unless necessary; best to measure on RF connector	Loss = 0.6 dB through isolator. Best to measure on RF connector as in Table 1.	Z802, N801 (Vbat), R805, R801, Z803
Cell duplexer (Z803) out = diplexer (Z805) in (In singlemode phones, a resistor replaces the unused duplexer: R810 for PCS only, R811 for Cell only)	8, Figure 5. Probing here not recommended unless necessary; best to measure on RF connector	Loss = 1-3 dB through duplexer	Z803, Z805, Z804, L750, N750, X814. If no cable connected to X814, then additionally: X811.

Table 2: RF/Analog Probing for Cell/AMPS Transmitter

Probing Point	Probing location on board	Probed absolute power (dBm) or gain/loss (dB), or voltage (v)	Where to start checking if RF power not correct (soldering, shorts, DC power applied if active, correct voltage of DC signals, otherwise replace)
UHF LO at 1009.62 MHz for channel 384	10E, Figure 5. Can probe on top of plastic to check for presence of LO, but won't read accurate power.	Power approximately -3 dBm	Check to see if LO is present. If no LO present, check R515, C511, C501, C532. Make sure there is 2.7v at TP 10B. If voltage is less than 2.6v, refer to Baseband regulator troubleshooting. If voltage is 2.7v, check G502 at TP 10A with a FET probe to see if UHF LO is present. Check that 19.2MHz clock is present at TP 10C. If LO is present but unlocked, check C518, C508, R508, R503, C509, R550, and C550. Pay attention to C508, as it is easily damaged. If LO is present and locked, but doesn't appear at TP 10E, check R519, R509, C506, N502, L501, C514, and C519.
VHF LO at 346.2 MHz for cell band, any channel	11a, Figure 5 (you can touch top of plastic to verify presence of LO, but this won't measure amplitude accurately)		N601, C612, C613, R607, R605, C632, R606, C618, R609, C629, V602, C637, V601, C630, C631, L611, C638, R604, R601, R602, R613

Table 3: DC probing for Cell/AMPS transmitter

Item to check	Setting	DC probing location on board	DC Voltage	Items to check if voltage incorrect
TX RF AGC	See Table 1	12, Figure 8	See Table 1	D400 (UPP), R433, C426, R434, C427, C429, V420, N601
TX IF AGC	See Table 1	13, Figure 8	See Table 1	D400 (UPP), R427, C422, R428, C423, C430, V421, N601
PA AGC	See Table 1	14, Figure 8	See Table 1	D400 (UPP), R430, C424, R431, C425, C431, V422, N601
PD_CELL	High for TX on, Low for TX off	49, Figure 5	High=2.6v Low=0v	N601, C649, N603 (pin 4)
VREFRF02	fixed	50, Figure 5	1.35v	D200, C606, N601

Table 3: DC probing for Cell/AMPS transmitter

Item to check	Setting	DC probing location on board	DC Voltage	Items to check if voltage incorrect
PA_BOOST	N/A	N/A	N/A	N/A

Table 4: RF/Analog Probing for PCS transmitter

Probing point	Probing location on board	Measured power (dBm) using RF probe, or gain/loss (dB)	What to check if RF power not correct (soldering, shorts, DC power applied if active, correct voltage of DC signals, otherwise replace)
Robin (N601)out = PCS Balun (T603) in	16a and 16b, Figure 5	Easiest to probe on balun output as per Table 1. Nominal loss through Balun = 1 dB, but it will appear as 1-2 dB gain due to impedance. On Robin output you may see amplitude imbalance between 2 sides of probing point 16 due to impedance differences, (less in cell).	N601 (also check VR2, VR3, VR6, VRIO, include check of AGCs as in Table 5, check VREFRF02 as in Table 5), T603, L609, L610, C624, C647, L666, C646, L667, C660, N602 (including check for 3.6v on pins 7 and 9), D400
PCS Balun (T603) out = Hornet (N602) in	17, Figure 5	See Table 1.	T603, L609, L610, C624, C647, L666, C646, L667, C660, N602 (including check for 3.6v on pins 7 and 9), D400
Hornet (N602) out = PCS TX SAW filter (Z601) in	18a for channels 25-599, 18b for channels 600-1175, both Figure 5	Gain=14.5-17.5 dB through Hornet	N602 (including: ensure 3.6v on pins 7 and 9; ensure PD_PCS high as in Table 5; and check PCS_CTRL as in Table 5 according to the channel used), Z601, C611, C635, C634, C627, C645, N605 (including FILSEL1 and FILSEL2 as in Table 5)
PCS TX SAW filter (Z601) out = switch (N805) in	19a for channels 25-599, 19b for channels 600-1175, both Figure 5	Loss=2-3.5 dB through filter	N602 (including: ensure 3.6v on pins 7 and 9; ensure PD_PCS high as in Table 5; and check PCS_CTRL as in Table 5, according to the channel used), Z601, C611, C635, C634, C627, C645, N805 (including FILSEL1 and FILSEL2 as in Table 5)
Switch (N805) out = PCS PA (N802) in	20, Figure 5	Loss=0.5 – 1.0 dB through switch	N805 (including FILSEL1 and FILSEL2 as in Table 5), N802 (including check for 3.6v on Vbat), C809, C814, C808

Table 4: RF/Analog Probing for PCS transmitter

Probing point	Probing location on board	Measured power (dBm) using RF probe, or gain/loss (dB)	What to check if RF power not correct (soldering, shorts, DC power applied if active, correct voltage of DC signals, otherwise replace)
PCS PA (N802) out = PCS isolator (Z801) in	21, Figure 5. Probing here not recom-men-ded unless neces-sary. Best to measure on RF connector.	See Table 1. Best to measure on RF connector.	N802 (3.6v on Vbat), Z801, R802, L801, L802, D400, N601 (since Iref, also check PA_AGC as in Table 5)
PCS isolator (Z801) out= PCS duplexer (Z804) in	22, Figure 5	Loss=0.6 dB through isolator	Z801, Z804
PCS duplexer (Z804) out = diplexer (Z805) in. In singlemode phones, a resistor replaces the unused duplexer: R810 for PCS only, R811 for Cell only.)	23, Figure 7	Loss=3 dB through PCS duplexer, TX to ANT port	Z801, N802 (Vbat), R802, Z804, Z801, Z805, L750, N750, X811 X814
Diplexer (Z805) out= RF connector (X814) in.	9, Figure 7	Loss=0.5 dB through diplexer	Z803, Z804, L750, N750, C801, L812, X814. If no cable connected to X814, then additionally: X811
UHF LO at 2088.1 MHz for PCS on channel 600	10E, Figure 5. Can probe on top of plastic to check for presence of LO, but won't read accurate power	Approx –3 dBm	Check to see if LO is present. If no LO is present, check R515, C511, C501, C532. Make sure there is 2.7V at TP 10B. If voltage is less than 2.6V, then refer to baseband regulator troubleshooting. If voltage is 2.7V, check G502 at TP 10A with a FET probe. Check that the 19.2 MHz clock is present at TP 10C. If LO is present but unlocked, check C518, C508, R508, R503, C509, R550, and C550. Pay particular attention to C508, as it is easily damaged. If LO is present and locked, but doesn't appear at TP 10E, then check R519, R509, C506, N502, L501, C514, and C519.
VHF LO at 416.2 MHz for PCS, any channel	11a, Figure 5		N601, C612, C613, R607, R605, C632, R606, C618, R609, C629, V602, C637, V601, C630, C631, L611, C638, R604, R601, R602

Table 5: DC probing for PCS transmitter

Item to check	Setting	DC probing location on board	DC voltage	Items to check if voltage incorrect
TX RF AGC	See Table 1	12, Figure 8	See Table 1	D400 (UPP), R433, C426, R434, C427, C429, V420
TX IF AGC	See Table 1	13, Figure 8	See Table 1	D400 (UPP), R427, C422, R428, C423, C430, V421
PA AGC	See Table 1	14, Figure 8	See Table 1	D400 (UPP), R430, C424, R431, C425, C431, V422
Filter select 1	Low for ch 25-599, high for ch 600-1175	30a, Figure 5	Low=0v High=2.5v min	N601, N605, C650
Filter select 2	High for ch 25-599, low for ch 600-1175	30b, Figure 5	Low=0v, high=2.5v min	N601, N605, C608
PCS_ CTRL	Low=ch 600-1175, high = ch 25-599	52, Figure 5	Low=0v, high= 1.9v min	N601, N602 (pin1)
PD_PCS	High= TX on, Low = TX off	53, Figure 5	High=2.6v min, low=0v	N601, N603, C611

Receiver Probing

Table 6: Receiver PDM values

	PDM lower limit	PDM upper limit	PDM mean	PDM mean voltage	RX power in	RSSI
AMPS ch 384 LowGain	2	102	55	0.98	-65 dBm	should be within +/- 2dB of actual RX signal above - 104 dBm, +2/-4 below -104
AMPS ch 384 HighGain	127	215	173	1.19	-65 dBm	
CELL ch 384 Low-Gain	-1	106	60	0.99	-65 dBm	
CELL ch 384 High-Gain	-119	-3	-64	0.78	-95 dBm	
PCS ch 600 Low-Gain	16	118	72	1.01	-65 dBm	
PCS ch 600 High-Gain	-109	7	-55	0.79	-95 dBm	

In AMPS, ensure 230 mV on I,Q traces of Batman out, probing point 40 of Figure 6.

Use CW signal for AMPS, use CDMA signal for CELL and PCS. Call box can generate both.

Table 7: RF probing for Cell CDMA and AMPS front end receiver

Probing point	Probing location on board	Probed absolute power (dBm) or gain/ loss (dB)	What to check if RF power not correct (soldering, shorts, DC power applied if active, correct voltage of DC signals, otherwise replace)
Diplexer (Z805) out= cell duplexer (Z803) in.	8, Figure 7	Loss=0.5 dB through diplexer	X800, L812, C801, Z805, Z803
Cell duplexer (Z803) out= Alfred (N750) in	32, Figure 5	Loss=2-4 dB through duplexer	Z803, L750, N750 (VRX)
Alfred (N750) LNA out= cell RX saw (Z751) in	33, Figure 7	Gain=12-14 dB for high gain mode (GAIN_ CTL=high. Use RF AGC status window to monitor state.), Loss=-3 to –5 dB for low gain	N750 (Also ensure BAND_SEL low as in Table 9. Also IF_SEL low for CDMA and high for AMPS, as in Table 9. Ensure GAIN_CTL is high if RX power is below the LNA switch point.), Z751, C755, L752, C757, R764, C753, R768, C756
Cell RX saw (Z751) out=Alfred (N750) mixer in	34, Figure 7	Loss=1-3 dB through SAW filter	Z751, N750, R765, C750, R768, C756, L757, C758
UHF LO at 1009.62 MHz in Cell CDMA/AMPS for channel 384	10D, Figure 7. Can probe on top of plastic to check for presence of LO, but won't read accurate power	Approx –3 dBm	Check to see if LO is present. If no LO is present, check R515, C511, C501, C532. Make sure there is 2.7V at TP 10B. If voltage is less than 2.6V, then refer to baseband regulator troubleshooting. If voltage is 2.7V, check G502 at TP 10A with a FET probe to see if UHF LO is present. Check that the 19.2MHz clock is present at TP 10C. If LO is present but unlocked, check C518, C508, R508, R503, C509, R550, and C550. Pay particular attention to C508, as it is easily damaged. If LO is present and locked, but doesn't appear at TP 10D, then check R505, R507, L771.

Table 8: RF probing for AMPS back end receiver

Probing point	Probing location on board	Probed absolute power (dBm) or gain/ loss (dB)	What to check if RF power not correct (soldering, shorts, DC power applied if active, correct voltage of DC signals, otherwise replace)
Alfred (N750) mixer out= AMPS RX IF saw (Z752) in	36, Figure 6	This point not 50 ohms. Will measure approx -28 dBm for -52 dBm input and RX AGC PDM=225.	N750 (Also ensure BAND_SEL low as in Table 9. Also IF_SEL low for CDMA and high for AMPS, as in table 3d.), R765, C750, L771, R768, C756, L770, L757, C758, L755, C769, R750, L753, C759, C766, C784, L764, C781, Z752
AMPS RX IF filter (Z752) out= Bat-man (N701) in	37, Figure 6	This point not 50 ohms. Will measure approx -46 dBm for -52 dBm input and RX AGC PDM=225.	Z752, L765, C777, L766, C778, L768, L767, C779, N701 (VR5, VR7, VIO)
Batman (N701) out= UEM (D200) in	40, Figure 6	See Table 6, RSSI most useful.	N701 (VR5, VR7, VIO, ensure 1.35v on VREFRF01 as in Table 9, also check RX_IF_AGC as in Table 9), R706, C704, R705, R704, V701, C716, L701, C702, C715, R702, C714, R703, C701,
VHF LO at 256.2 MHz	39, Figure 6		N701, C701, C714, R703, R702, C715, R704, V701, C716, L701, C702, R705, C706

Table 9: DC probing for receiver

Item to check	Setting	DC probing location on board	DC voltage	Items to check if voltage incorrect
RX IF AGC	See Table 6 for PDM settings	60, Figure 6	See Table 6 for typical voltages	D400, R435, C428, C435, N701
BAND_SEL	High=PCS Low=Cell	54, Figure 7	High=2.4vmin, Low=0.3v max	N701, N750, R768, C756, G502
GAIN_CTL	High=LNA high gain, Low=LNA low gain (both Cell & PCS)	55, Figure 7	High=2.4vmin, Low=0.3v max	N701, N750, R764, C753
IF_SEL	High= AMPS, Low= CDMA	56, Figure 7	High=2.4vmin, Low=0.3v max	N701, N750, R765, C750

Table 9: DC probing for receiver

Item to check	Setting	DC probing location on board	DC voltage	Items to check if voltage incorrect
VREFRF01	fixed	57, Figure 6	1.35 v	D200, C706, N701

Table 10: RF probing for PCS front end receiver

Probing point	Probing location on board	Probed absolute power (dBm) or gain/ loss (dB)	Where to start checking if RF power not correct (soldering, shorts, DC power applied if active, correct voltage of DC signals, otherwise replace)
Diplexer (Z805) out= PCS duplexer (Z804) in.	23, Figure 7	Loss=0.5 dB through diplexer	X800, L812, C801, Z805, Z804, Z801, C752, L751, N750. (If all these are ok and it passes conducted test but fails radiated test, then check the following: L802, R823, L803, R824, X811, X810, X814, L851)
PCS duplexer (Z804) out= Alfred (N750) LNA in	42, Figure 7	Loss=1-3.5 dB through duplexer	Z804, Z801, Z805, C752, L751, N750 (including check for proper voltages on Alfred signaling as in table 3c)
Alfred (N750) LNA out= PCS RX saw (Z750) in	43, Figure 7	Gain=12-14 dB for high gain, Loss=-3 to –5 dB for low gain, use AGC status window to monitor gain status	N750 and supporting components (Also ensure BAND_SEL high as in Table 9. Also IF_SEL low for CDMA as in Table 9. Ensure GAIN_CTL high if RX power is below the LNA switch point), Z750
PCS RX saw (Z750) out=Alfred (N750) mixer in	44, Figure 7	Loss=1-4 dB	Z750, N750 and supporting components (including check for proper voltages on Alfred signaling as in Table 9)

Table 10: RF probing for PCS front end receiver

Probing point	Probing location on board	Probed absolute power (dBm) or gain/ loss (dB)	Where to start checking if RF power not correct (soldering, shorts, DC power applied if active, correct voltage of DC signals, otherwise replace)
UHF LO at 2088.1 MHz for PCS channel 600	10D, Figure 7. Can probe on top of plastic to check for presence of LO, but won't read accurate power	Approx –3 dBm	Check to see if LO is present. If no LO is present, check R515, C511, C501, C532. Make sure there is 2.7V at TP 10B. If voltage is less than 2.6V, then refer to baseband regulator troubleshooting. If voltage is 2.7V, check G502 at TP 10A with a FET probe. Check that the 19.2MHz clock is present at TP 10C. If LO is present but unlocked, check C518, C508, R508, R503, C509, R550, and C550. Pay particular attention to C508, as it is easily damaged. If LO is present and locked, but doesn't appear at TP 10D, then check R505, R507, L771.

Table 11: RF probing for Cell CDMA and PCS back end receiver

Probing point	Probing location on board	Probed absolute power (dBm) or gain/ loss (dB)	Where to start checking if RF power not correct (soldering, shorts, DC power applied if active, correct voltage of DC signals, otherwise replace)
Alfred (N750) mixer out= CDMA RX IF saw (Z753) in	46, Figure 6	This point not 50 ohms. Will measure approx -14 dBm for -52 dBm input and RX AGC PDM=225.	N750 and supporting components (Also ensure BAND_SEL low for Cell CDMA and high for PCS as in Table 9. Also IF_SEL low for CDMA as in Table 9), L754, C782, C767, C761, C786, Z753
CDMA RX IF saw (Z753) out= Batman (N701) in	47, Figure 6	This point not 50 ohms. Will measure approx -47 dBm for -52 dBm input and RX AGC PDM=225	Z753, N750 and supporting components (including check for proper voltages on Alfred signaling as in Table 8), L754, C782, C767, L759, C770, C771, C772, L760, L761, N701
Batman (N701) out= UEM (D200) in	40, Figure 6	Easiest to use RSSI, see Table 6.	N701 (VR5, VR7, VIO, ensure 1.35v on VREFRF01 as in Table 9, also check RX_IF_AGC as in Table 9), R705, C704, R706, C706, C701, C714, R703, R702, C715, R704, V701, C716, L701, C702

Table 11: RF probing for Cell CDMA and PCS back end receiver

Probing point	Probing location on board	Probed absolute power (dBm) or gain/ loss (dB)	Where to start checking if RF power not correct (soldering, shorts, DC power applied if active, correct voltage of DC signals, otherwise replace)
VHF LO at 256.2 MHz	39, Figure 6		N701, C701, C714, R703, R702, C715, R704, V701, C716, L701, C702, R705, C706

RF Power Supplies

Table 12: DC supplies for RF circuitry

Supply	Voltage	Supplied components	Probing location
VR1A	4.75	VCTCXO, UHF PLL, Charge Pump	figure 9
VR1B	4.75	Robin	Not accessible
VR2	2.78	Robin, Power Detector	figure 9
VR3	2.78	Robin, VCTCXO	figure 9
VR4	2.78	UHF PLL	figure 9
VR5	2.78	Batman	figure 9
VR6	2.78	UHF LO Buffer	figure 9
VR7	2.78	Batman	figure 9
VIO	1.8	Robin, UHF PLL	figure 9
VRX	2.78	Alfred	figure 9
VPLL	2.78	UHF PLL	figure 9
VBAT	3.1-4.2	PA	figure 9

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Probing Diagrams

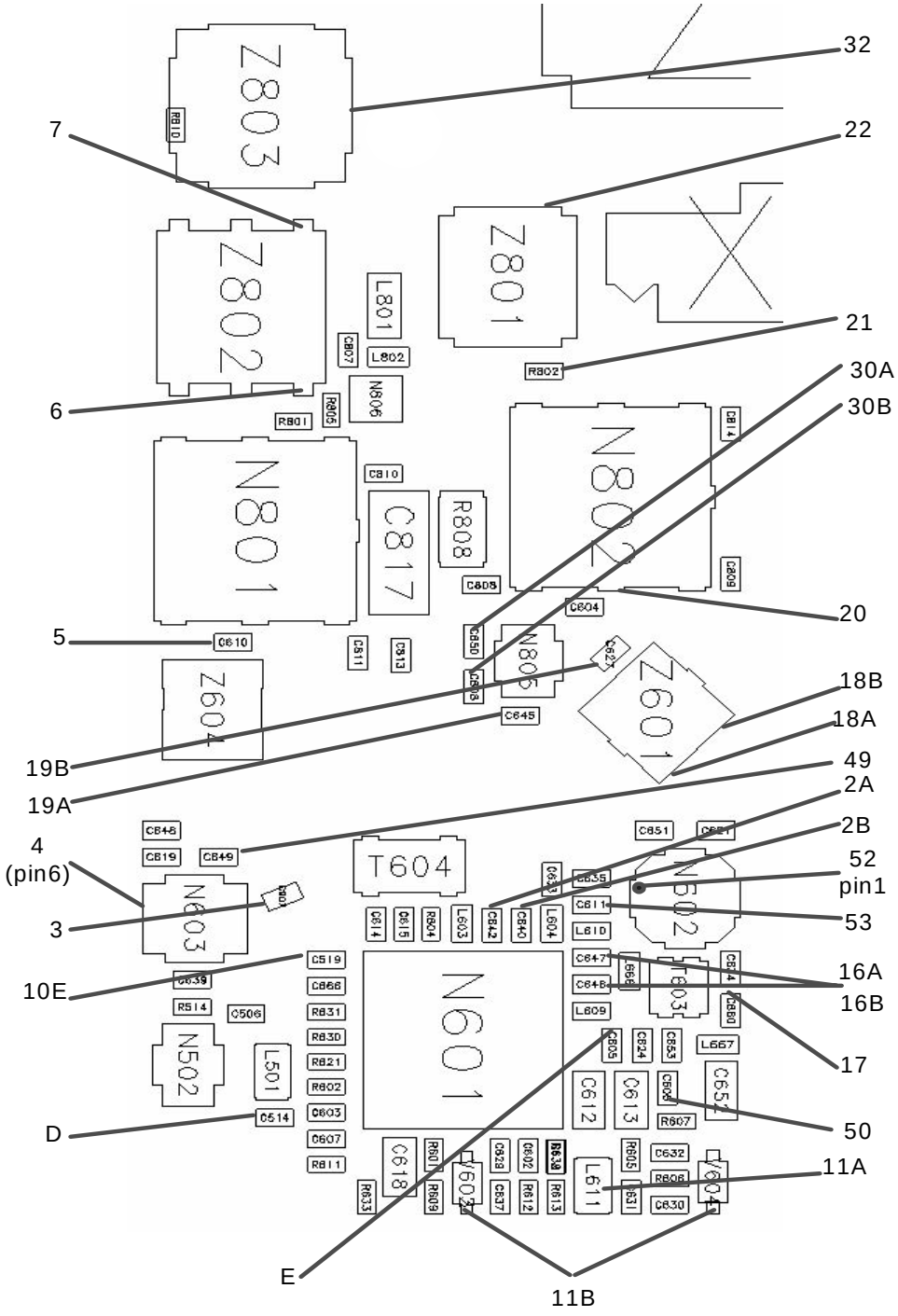


Figure 5: Probing diagram (TX components)

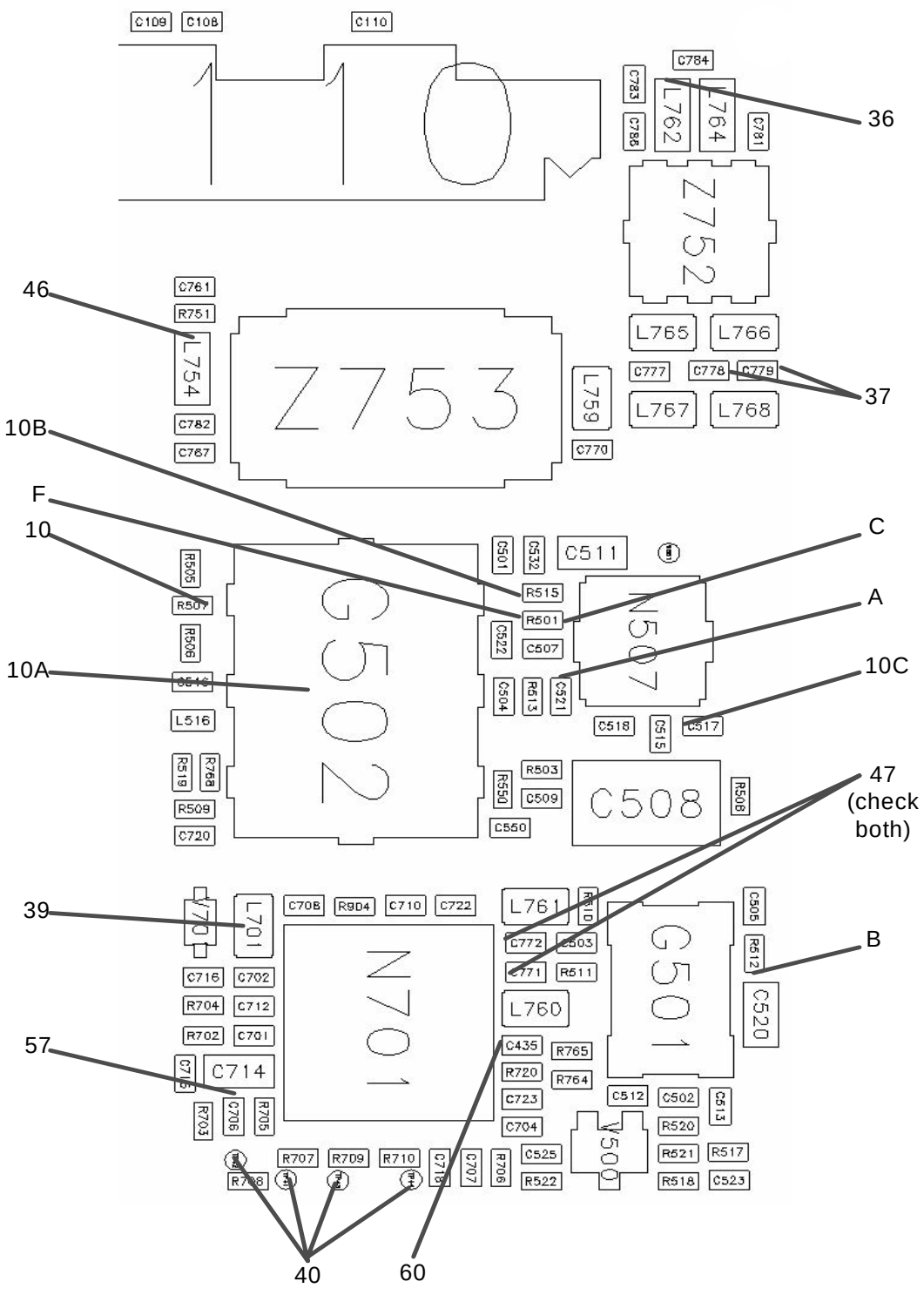


Figure 6: Probing diagram (RX IF components)

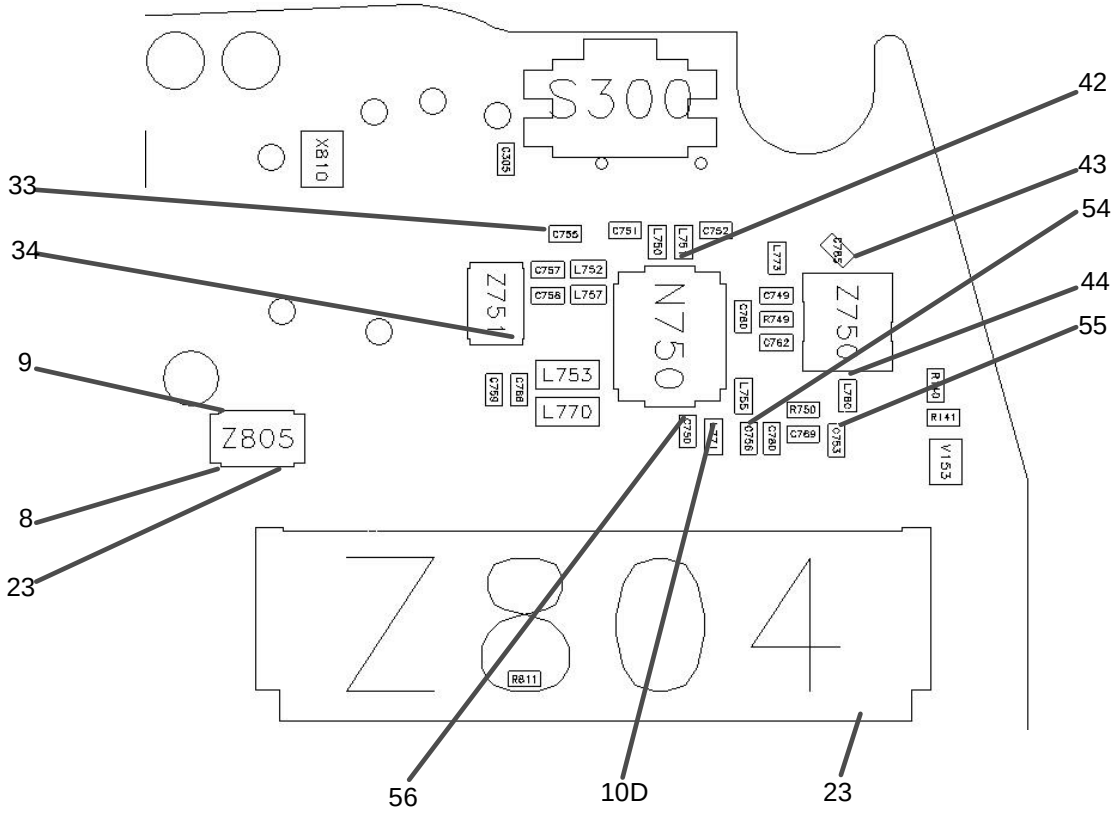


Figure 7: Probing diagram (RX LNA components)

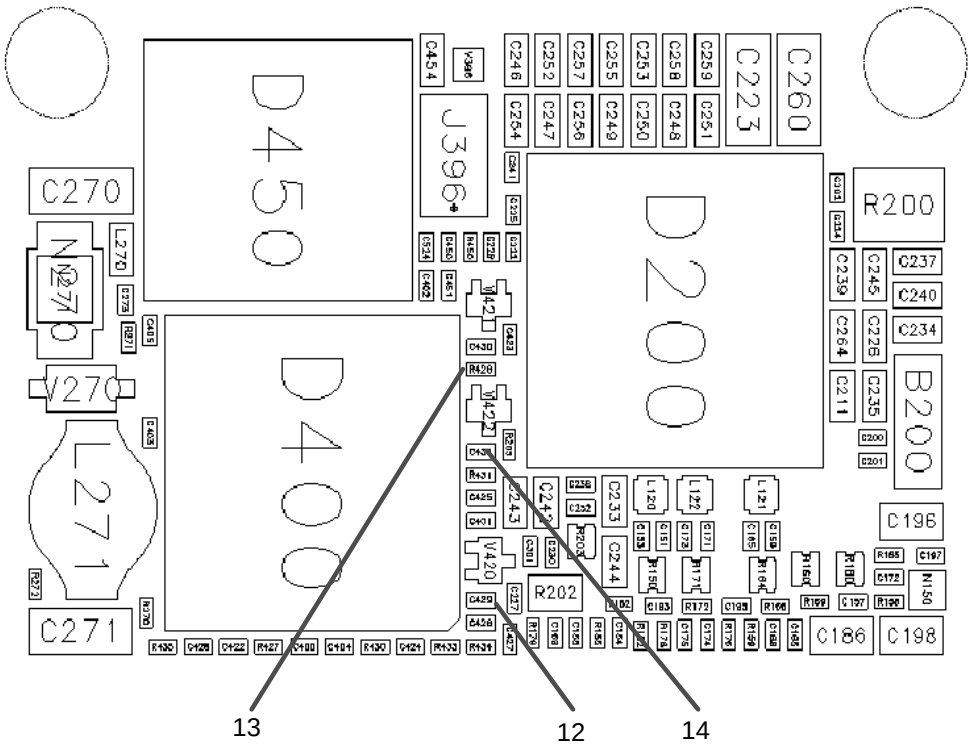


Figure 8: Probing diagram (BB area)

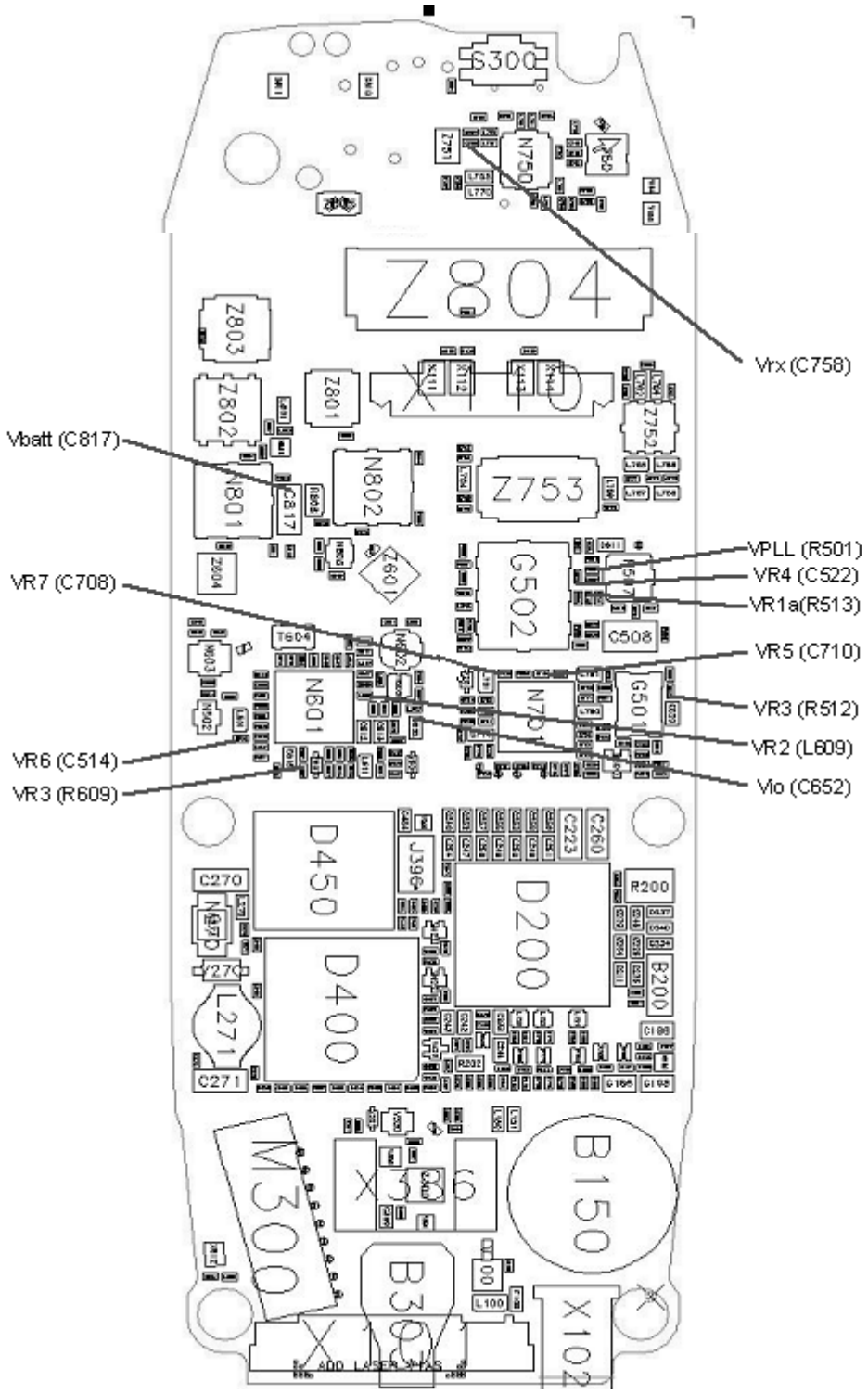


Figure 9: Probing diagram (voltage regulators)

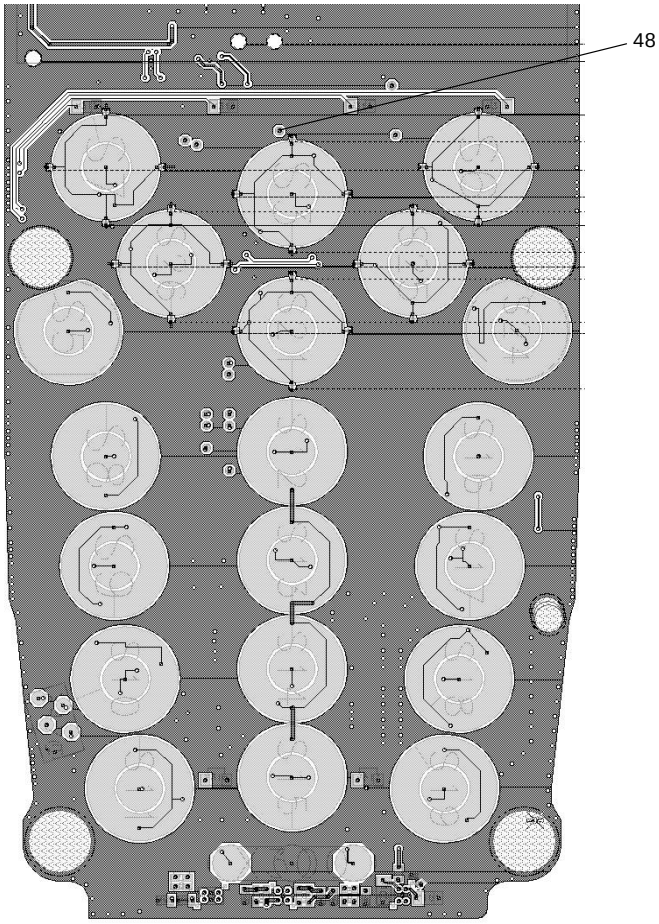
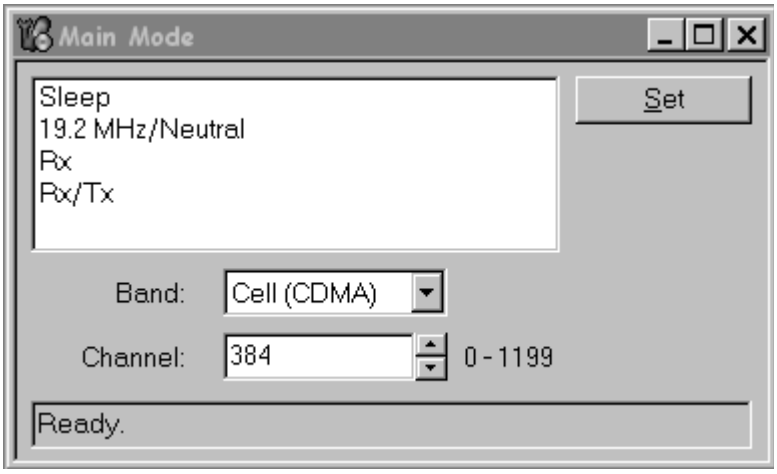


Figure 10: Probing diagram (power detector)

APPENDIX A: Phoenix Instructions

To turn on the PCS or Cell CDMA transmitter

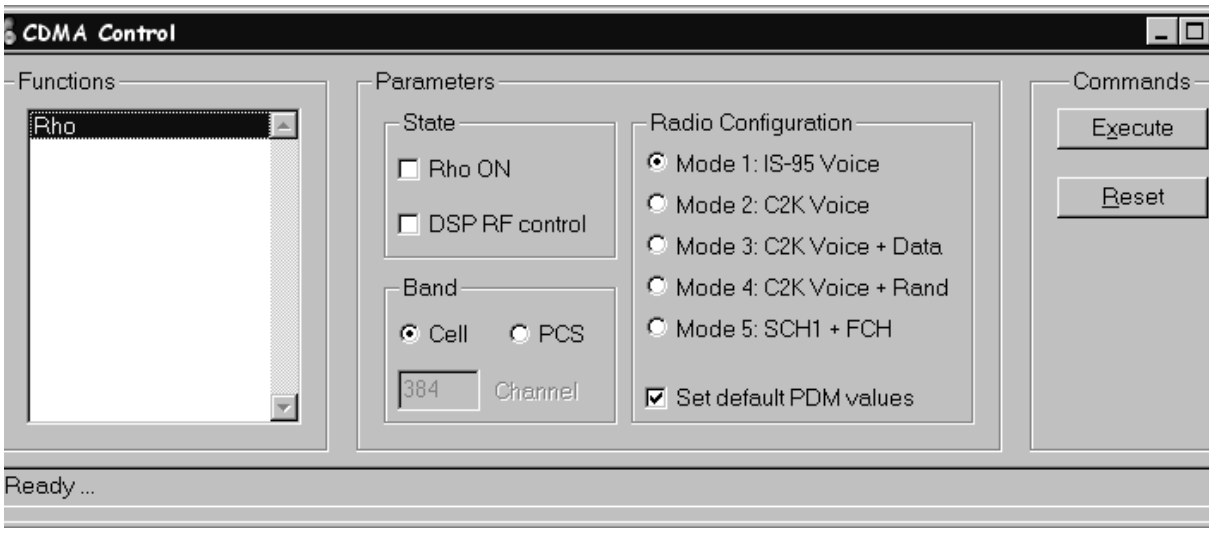
Under the "RF" menu, choose "main mode", which opens the dialog box shown below.



To turn on the transmitter, first turn on the carrier by highlighting "RX/TX" in the sub-

window at the top (which also turns on the receiver), typing the channel in the "channel" field, then clicking the **Set** button in the upper right hand corner.

Next turn on the modulation by opening the “CDMA Control” dialog box under the “DSP” menu. This dialog box is shown below.

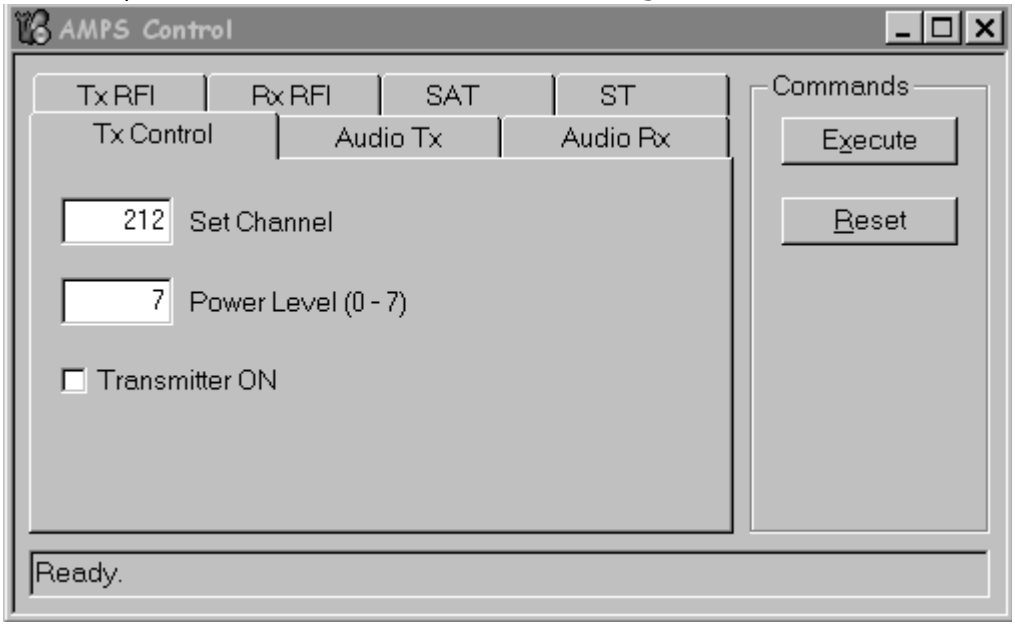


Highlight "Rho" in the "functions" field, and click "Rho ON" in the "state" field. Choose "Cell" or "PCS" in the "band" field. Under "Radio Configuration" choose the desired configuration. C2K is an abbreviation for IS2000. Click **Execute** button.

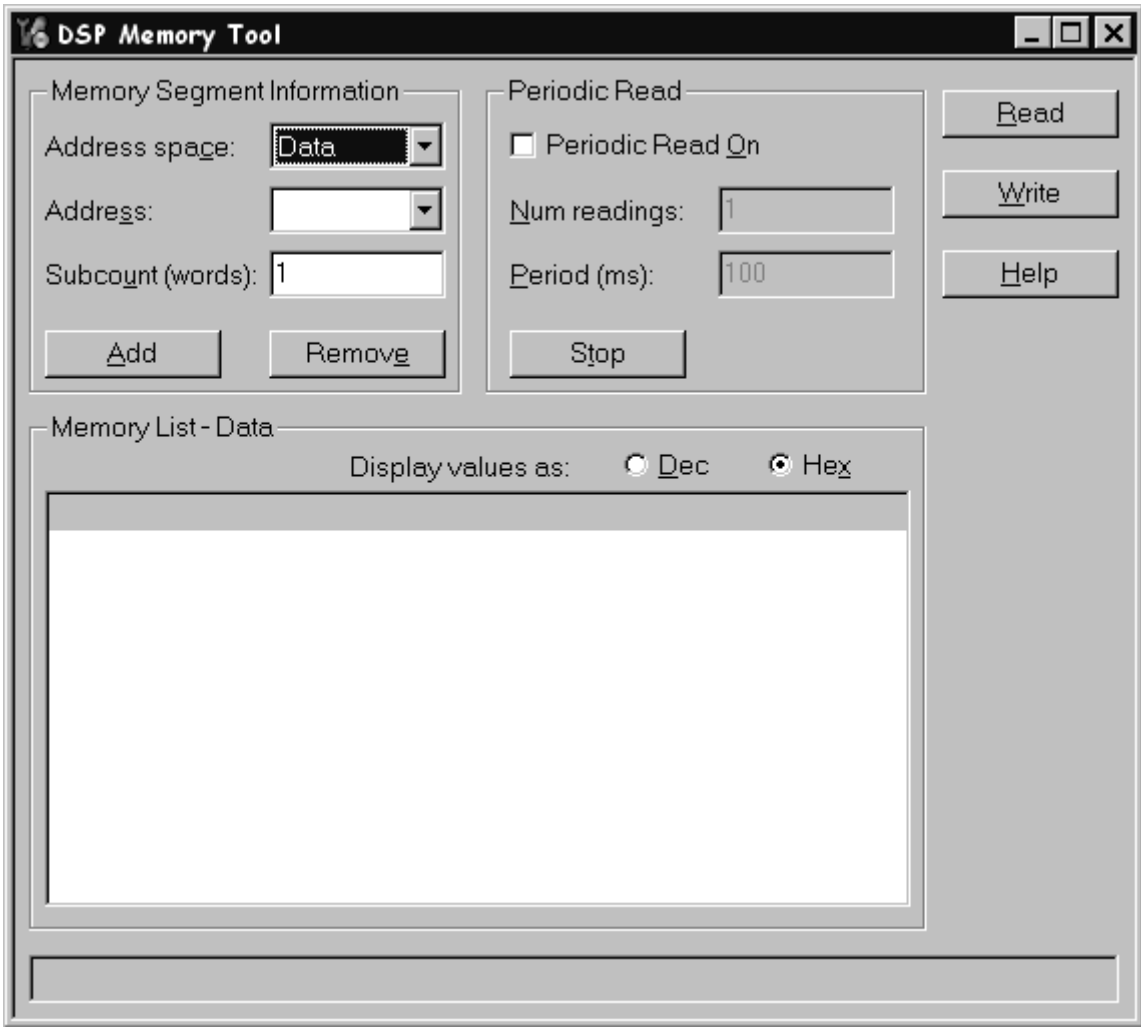
To turn on the AMPS transmitter

Eventually, the method will be to use the “RF Main Mode” dialog box as shown above, choosing “AMPS” in the “Band” field. However, at the moment there is a software problem with this method, with the result that once the AMPS transmitter is turned on in this manner, it does not respond correctly to AGC PDM adjustment.

As a temporary solution, the “AMPS Control” dialog box, shown below, can be used.



Select the desired channel and power level, click "Transmitter ON", then click **Execute**. The reason why this is a temporary solution is because in some instances, the AFC and AGC are not disabled, with the results that the signal will not be stable in frequency and will not respond to AGC PDM adjustment. If this is the case, manually disable the AFC and AGC using the "DSP Memory" dialog box shown below.



Choose the "Data" option in the "Address Space" field, type in the address, leave the "subcount" entry at "1", then click **Add** button. The address will then be displayed in the field in the lower half of the dialog box. Use this method to enter in both the AFC Disable and AGC Disable addresses. These addresses can be obtained from R&D, and they can change with software version. This is the reason this method is temporary.

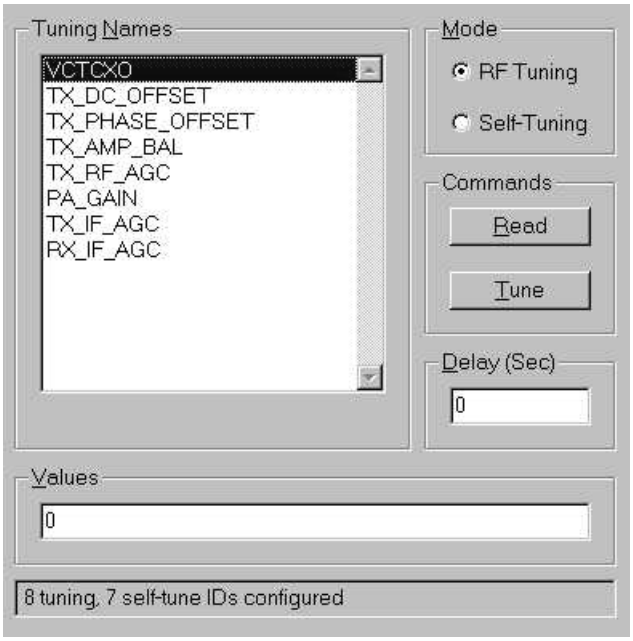
Once both addresses are entered, check "Periodic Read On", then click **Stop** button. Then click the **Read** button, which will display the values in both addresses. Both should be "1". Change both to "0" by clicking on the "1", which will highlight the data in the address, then you can edit the contents and change the "1" to a "0". Enter a return on your keyboard to enter the new value. Once the contents of both addresses are changed to "0", click the **Write** button, which writes them into the phone. This data will remain in the phone until the phone is powered down.

To turn on the receiver only, in any mode

To turn on the receiver only, use the “Main Mode” dialog box as shown previously, highlight "RX". In the "band" field, choose "Cell CDMA" or "PCS CDMA"

To verify a single, manual tuning

Open the “RF Tuning” dialog box, shown below. The tuning descriptions at the beginning of this document describe the tuning and tell you what you need to enter, if anything, and what values will be returned to you from the phone, if any.

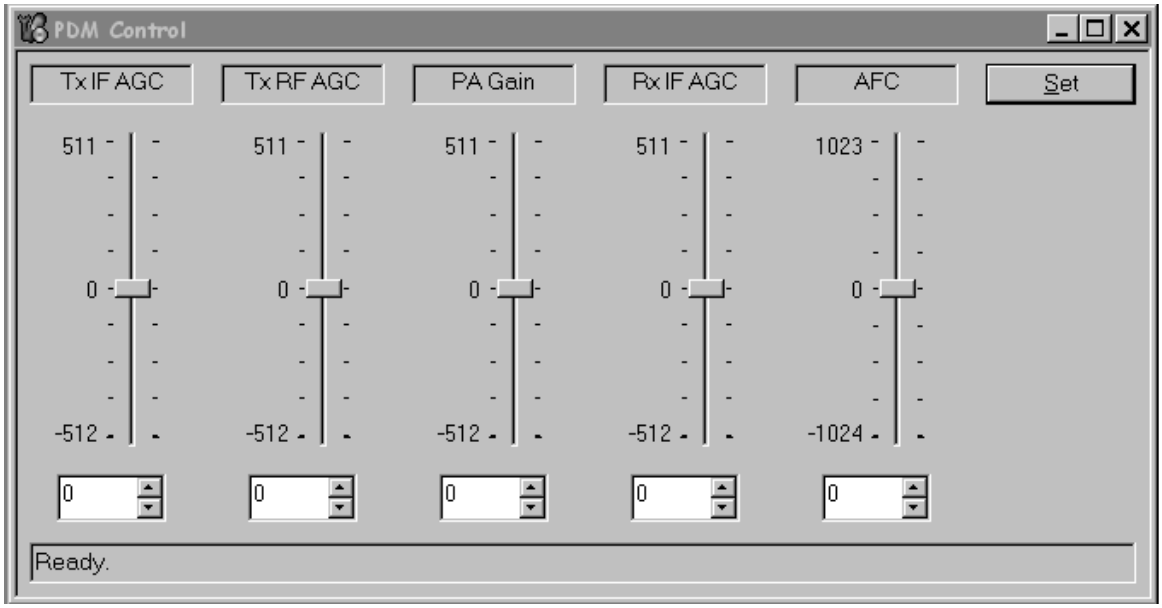


According to these descriptions, choose “self tuning” for self tunings, and “RF Tuning” for the others. Choose the appropriate test from the “tuning names” list. Values that you must enter are entered in the “values” dialog box. If more than one value is entered, enter a delay time in seconds in the “delay” box. This is the delay between applications of the multiple values entered. Three seconds is sufficient for all tests to run, however in certain cases you may want to increase the delay in order to closely observe the phone’s behavior during the tuning.

Any data returned from the phone is displayed on the status line, the box at the bottom which in the figure below says “8 tuning, 7 self-tune Ids configured”. If no tuning value is returned, this line will indicate if the tuning was successful or not. To begin a tuning, click the **Tune** button.

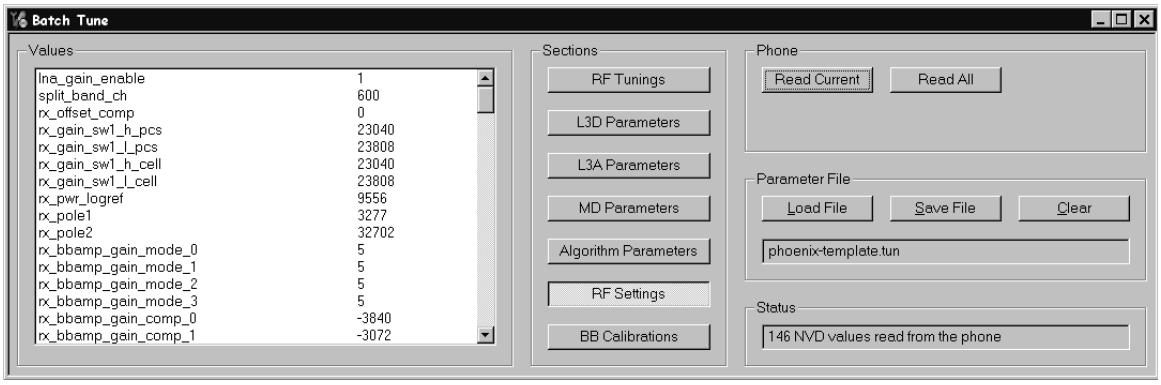
To adjust PDM values of AGCs and AFC

In the "PDM" dialog box, which follows, are several sliders, one each for each of the AGCs and the AFC. Drag the slider pointer with your mouse to the value that you want to set. The values are in decimal. Then click **Set** button. Alternatively, you can click the up and down arrows next to the value fields below the sliders, which will increase or decrease the value one step at a time. If you do this, you do not have to click **Set**.



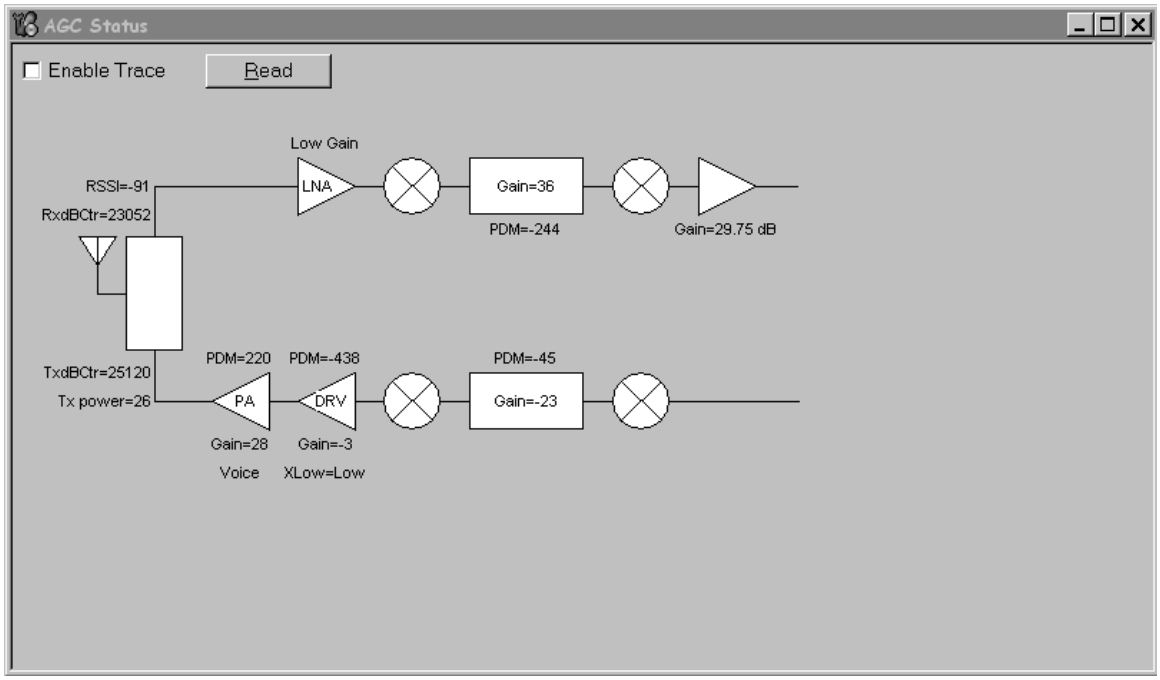
To read tuning values from the phone

Open the "Batch Tune" dialog box, as shown below. To read the tuning values from the phone, click **Read All** button under the "phone" heading. However, in order for the tuning values to be displayed, you must first load the template file by clicking **Load File** button under the "Parameter File" field. Ensure that the template file used is appropriate for the software version in the phone.



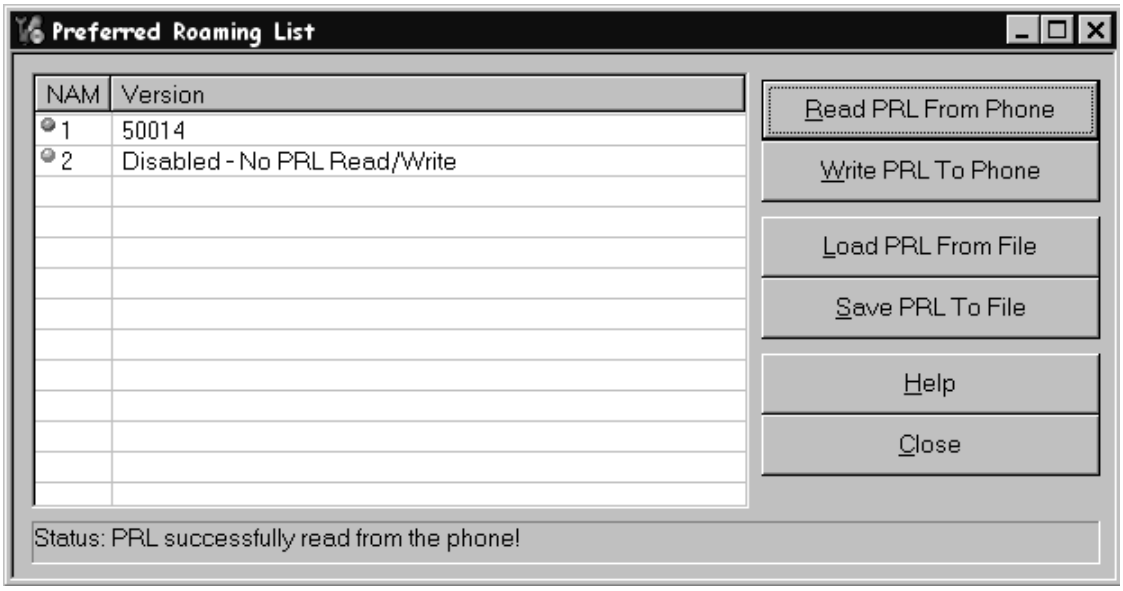
To read RSSI and AGC PDM values from the phone

Open the "AGC Status" dialog box, which follows. Click "Enable Trace". RSSI is the value near the antenna on the receiver side. The AGC PDM values are shown beside their respective variable gain amplifier in the block diagram. The TX AGC PDMs are, as shown in the diagram from right to left, IF_AGC, RF_AGC, PA_AGC.



To load a PRL into the phone

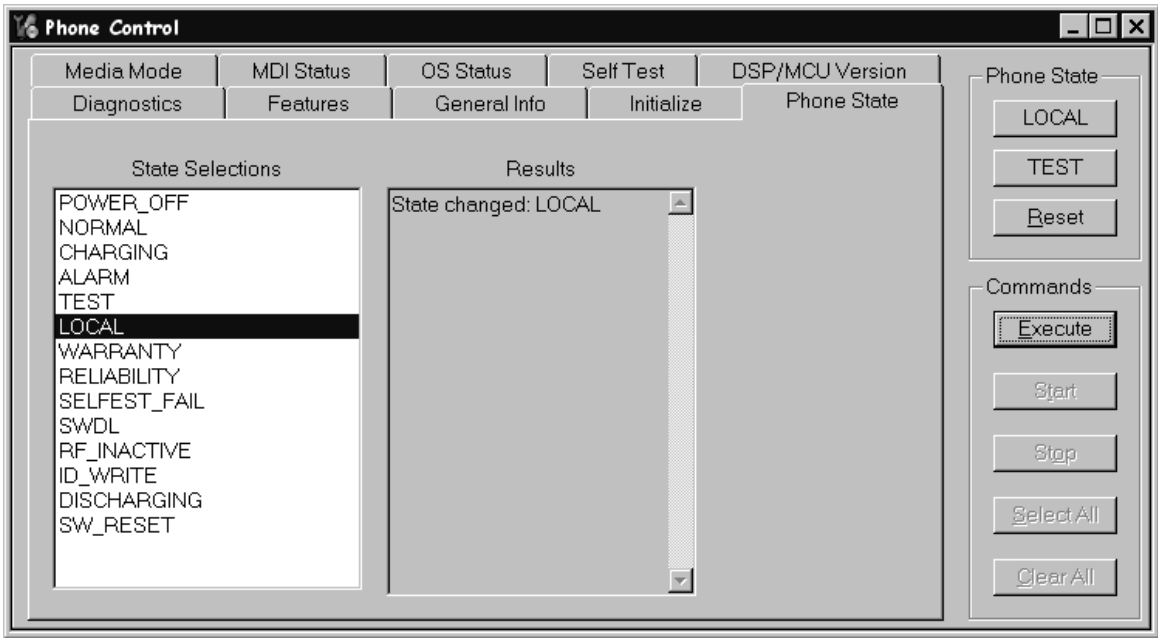
Use the "PRL" dialog box as shown below. Click the **Load PRL From File** button, and choose the desired file, which will then appear in the list on the left side of the window. Highlight the desired file in the list so that it is blue, then click the **Write PRL To Phone** button. At the bottom of the window, a status message will indicate if the file was loaded correctly or not.



To change between Local and Normal modes

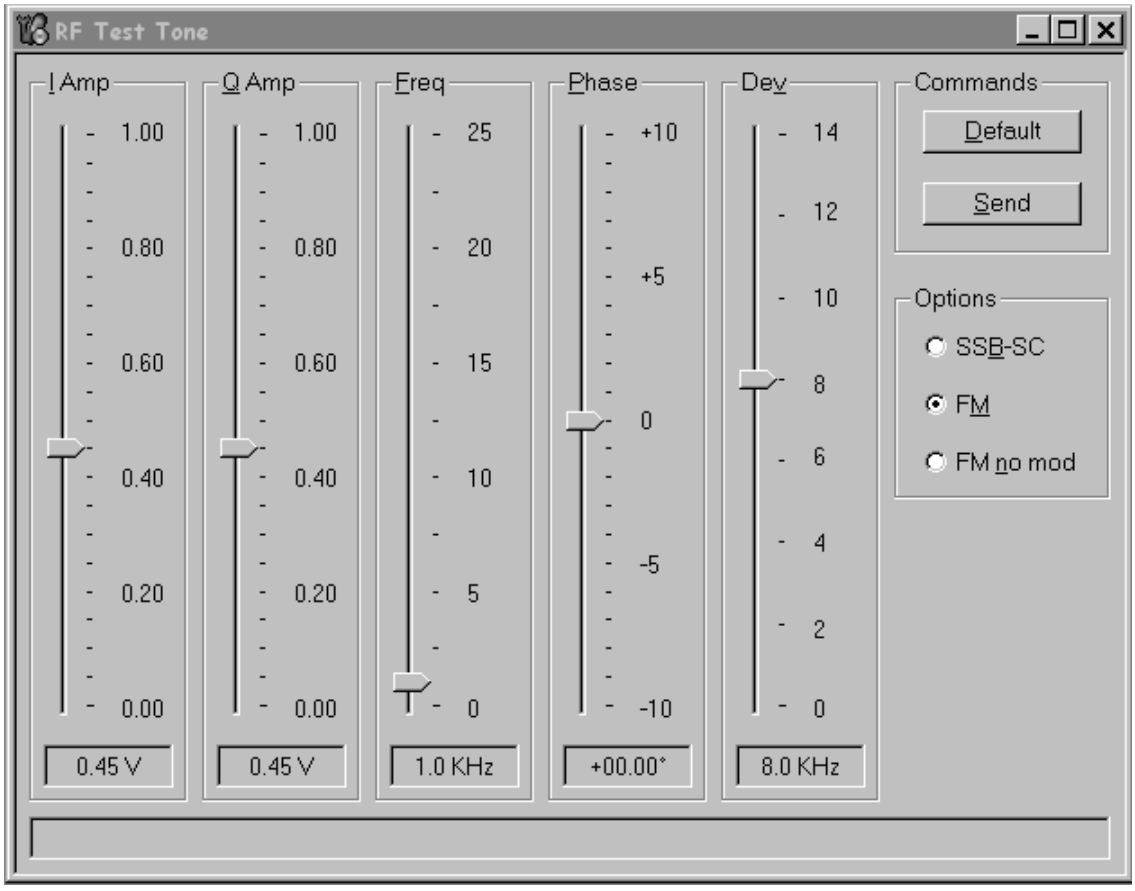
To make a call, the phone should be in normal mode. In normal mode, the phone software is running, and the phone will search for a pilot. To troubleshoot so that you can manually control the phone (not in a call), the phone should be in local mode. In local mode, the phone's software is not running and it will not search for a pilot. To switch

between normal and local modes, use the "Phone Control" dialog box as shown below. This setting will be lost if the phone is powered down.



To add a baseband test tone to the AMPS transmitter

To add a baseband test tone to the AMPS transmitter, open the "Test Tone" dialog box as shown below and set the parameters as desired.



APPENDIX B: Definitions

ACPR: Adjacent Channel Power Ratio. A ratio of power at an offset frequency as compared to the power at the center frequency.

ADC: Analog to Digital Converter

AGC: Automatic Gain Control

AFC: Automatic Frequency Control

CW: Continuous Wave. This is a pure sine wave with no modulation such as CDMA or FM.

DAC: Digital to Analog Converter

dB: A power ratio. Formula is 10log(power1/power2). It is used to denote differences, such as gain or loss. Power1 and power2 are in linear units such as W or mW.

dBm: A unit for an absolute power level. Formula is 10log(power in mW/1 mW).

LNA: Low Noise Amplifier

LO: Local Oscillator. This is a CW signal used to mix signals up or down to a different frequency.

PA: Power Amplifier

PDM: Pulse Density Modulation. This is used for control signals. The density of a stream of digital voltage pulses is varied proportionally to the desired control level, then it is converted to an analog voltage used as the control signal.

PLL: Phase Locked Loop. Used in Synthesizer circuits to generate an LO.

PPM: part per million

RSSI: Received Signal Strength Indicator

APPENDIX C: Block Diagrams

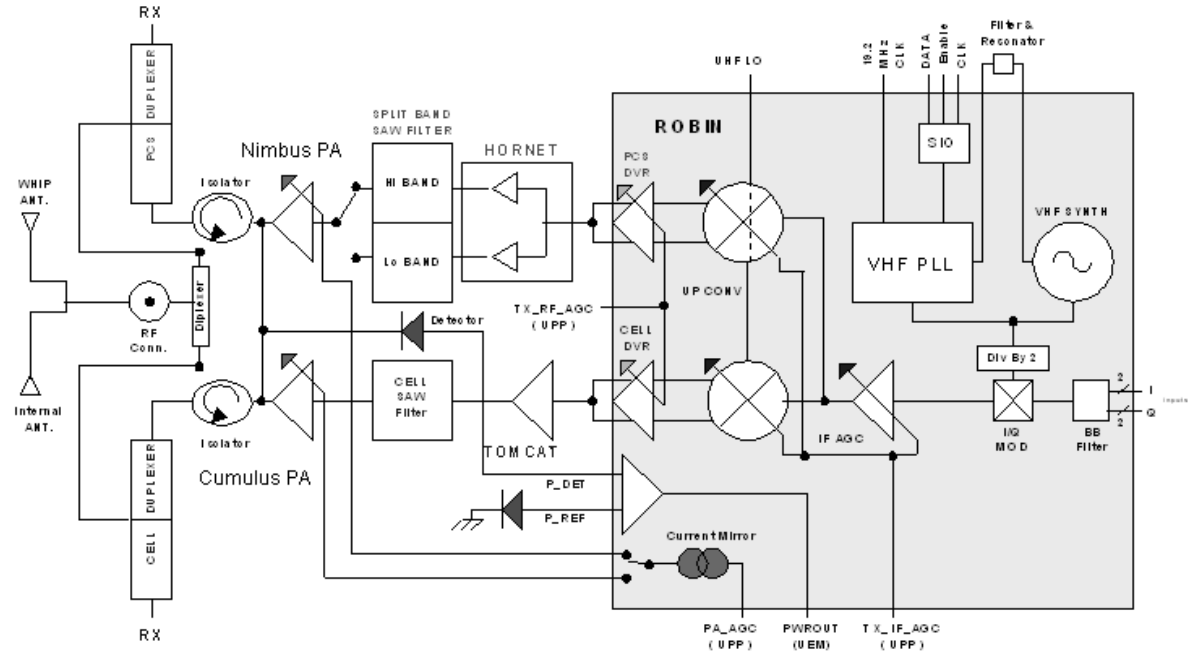


Figure 11: Transmitter Block Diagram

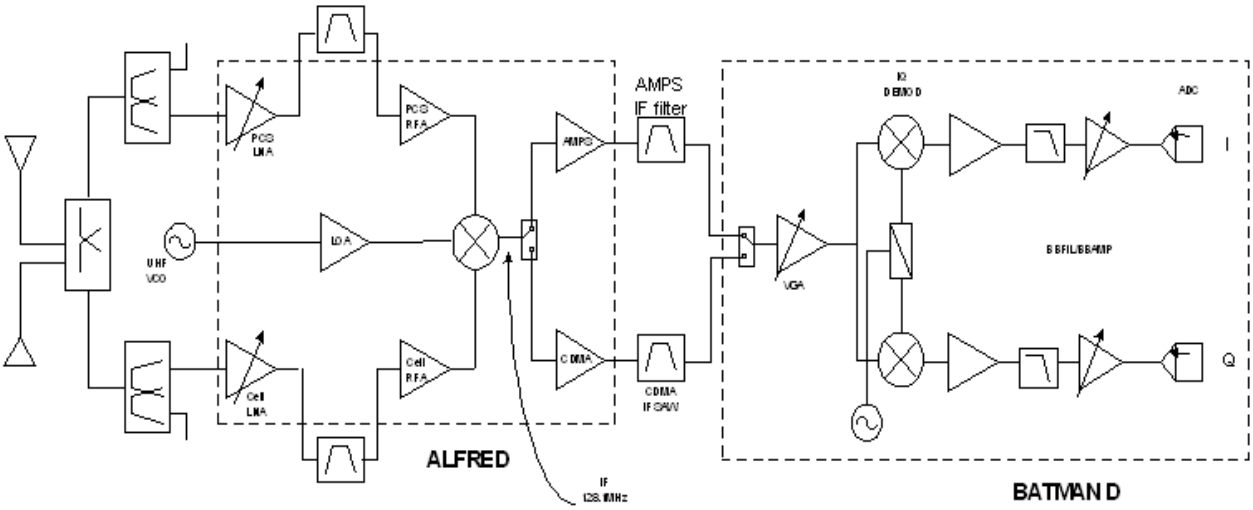


Figure 12: Receiver Block Diagram

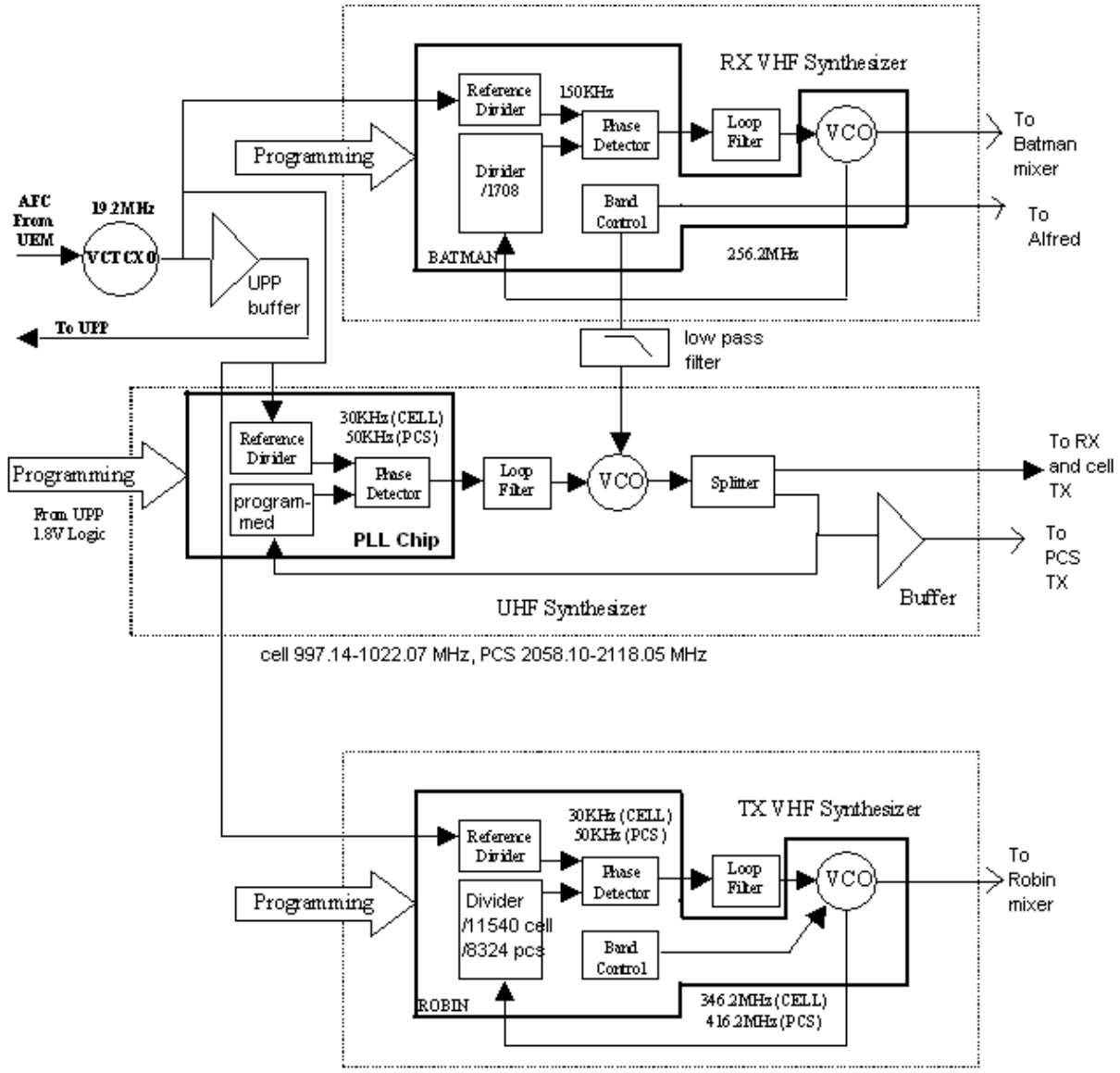


Figure 13: Synthesizer Block Diagram

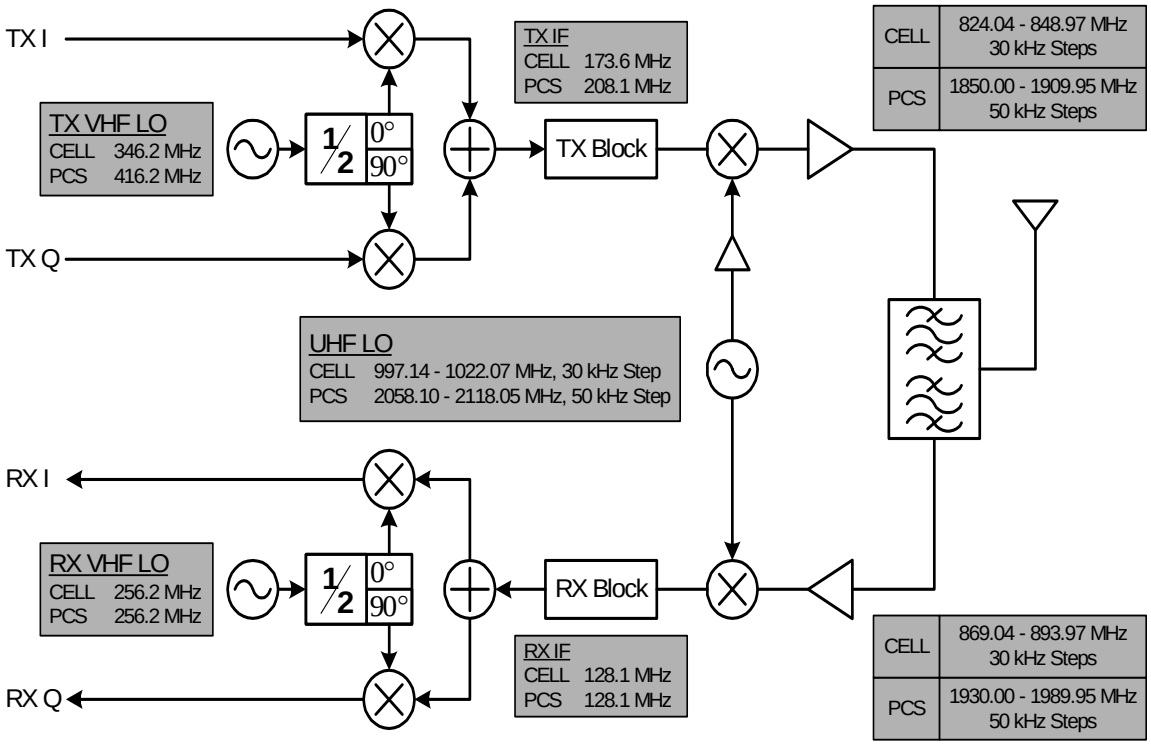


Figure 14: Frequency Plan

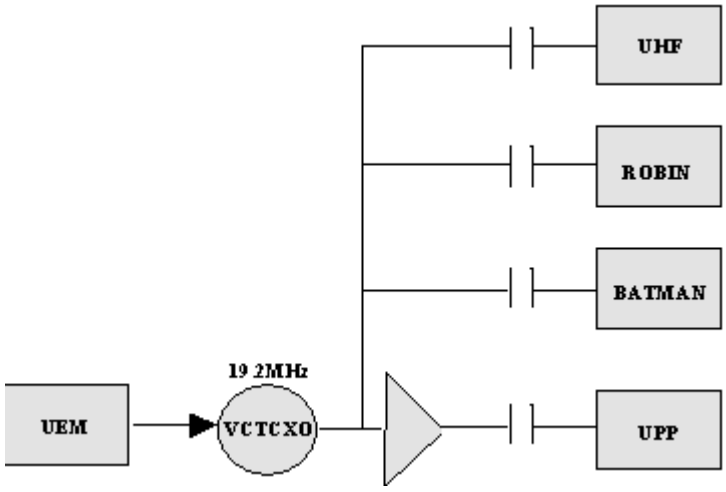


Figure 15: Distribution of VCTCXO tone at 19.2 MHz

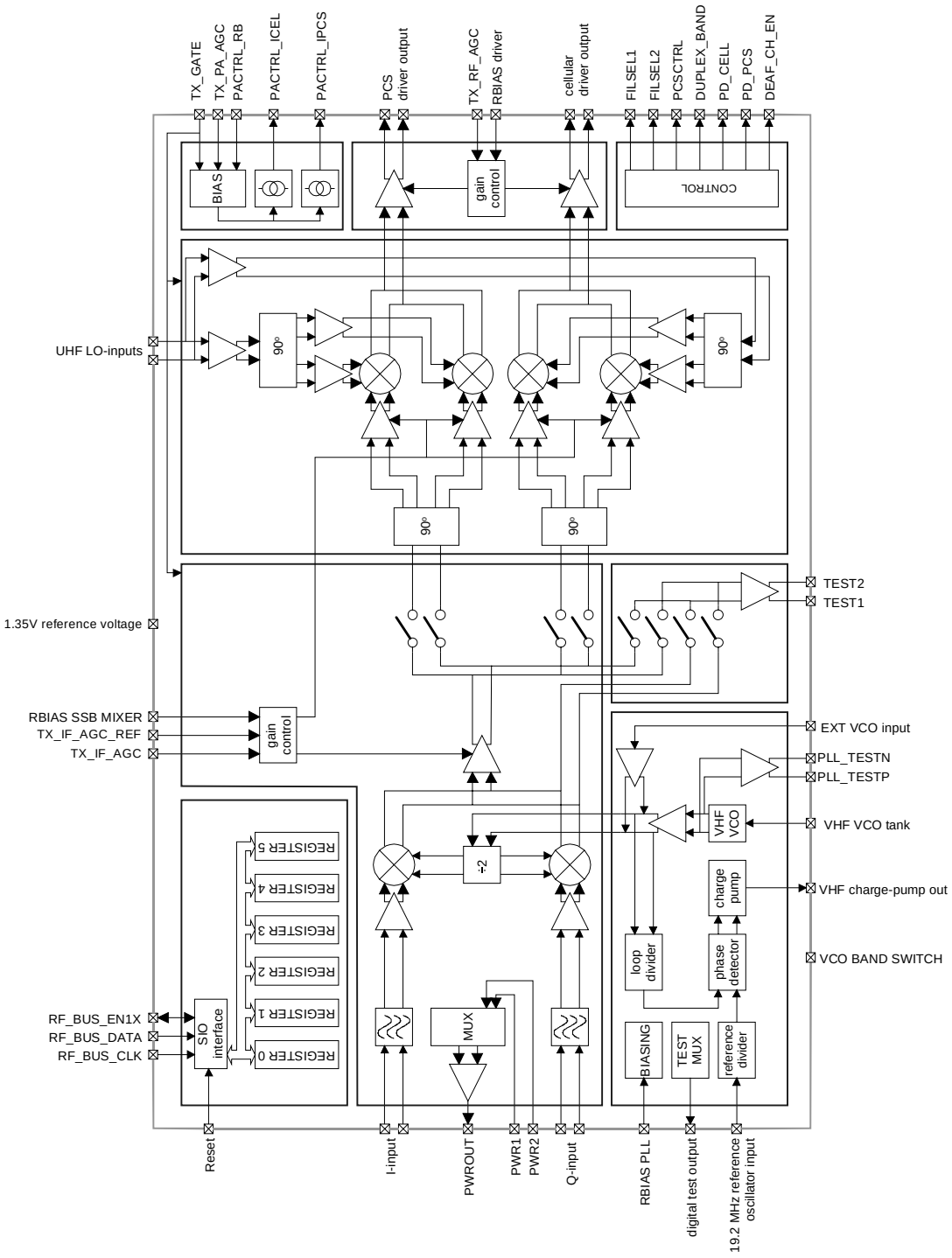


Figure 16: Detailed Robin Block Diagram

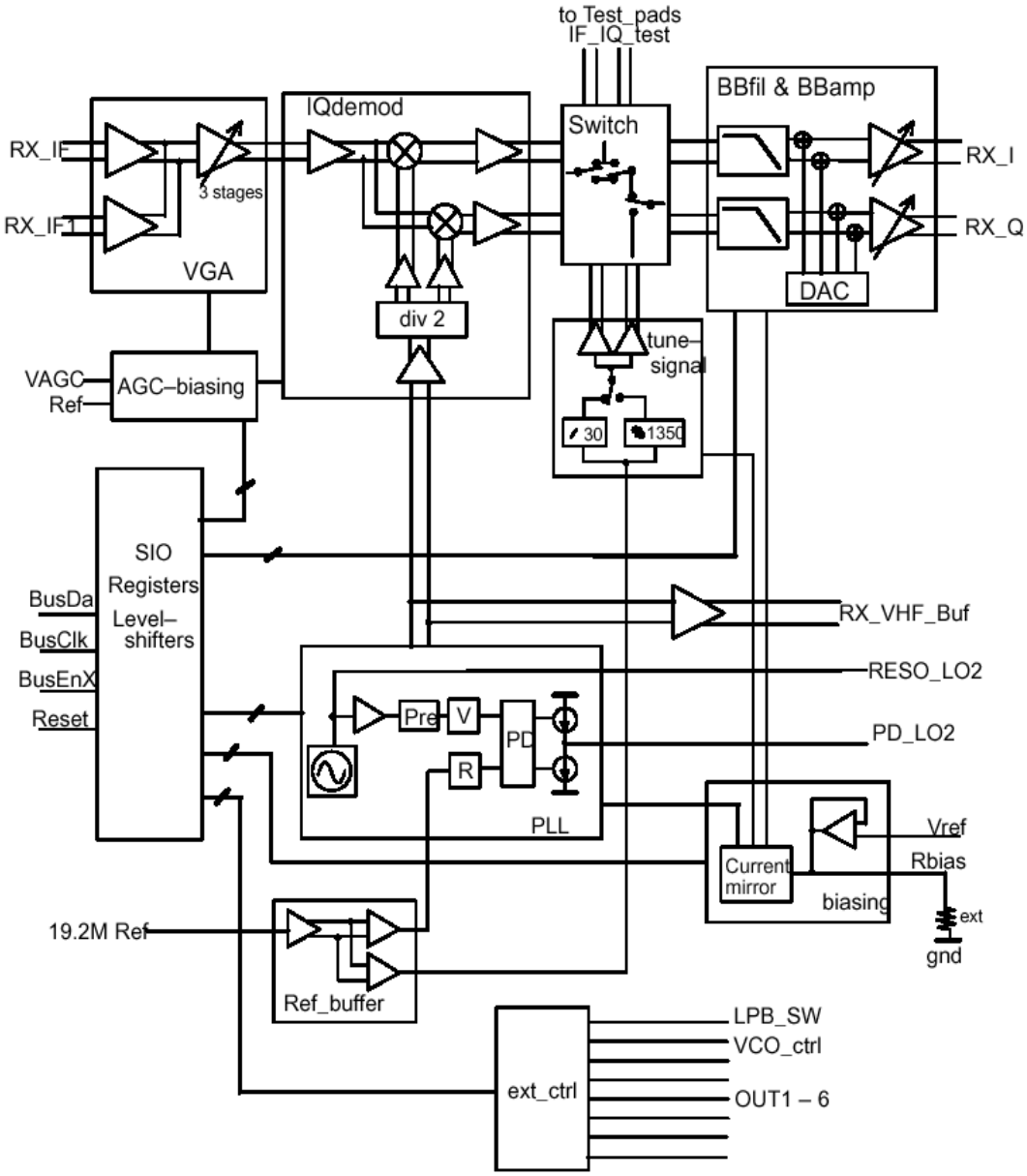


Figure 17: Detailed Batman Block Diagram

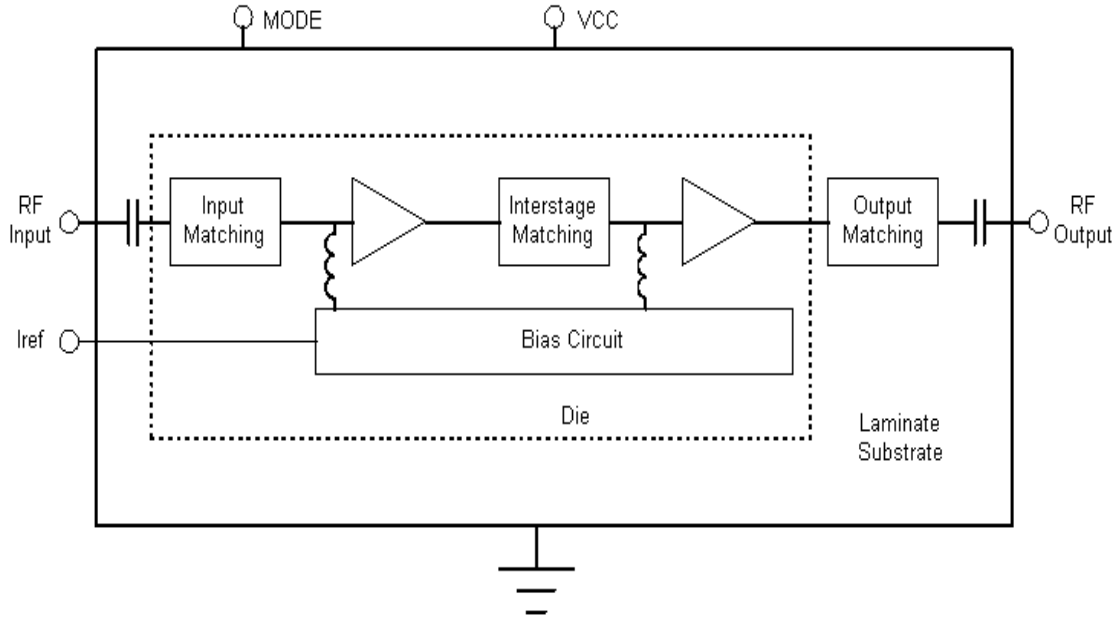


Figure 18: Block Diagram for both Cumulus (Cell PA) and Nimbus (PCS PA)

APPENDIX D:
Descriptions of selected components, signaling, and architecture

Robin (N601) Key Features

- Transmitter chip: both Cell & PCS
- Supports IS95, IS2000 & AMPS
- Input is baseband IQ signal, output is RF signal. Contains IF circuitry
- 84 ball TFBGA
- has 2 upconverters (BB to IF IQ modulator, IF to RF)
- contains on-chip VHF LO
- contains RF and IF Variable Gain Amplifiers, and part of circuitry for PA gain control
- contains op-amp as part of power detection circuit
- has serial interface for control by external digital controller
- 2.7v and 4.7v for analog functions, 1.8v for digital functions

Robin (N601) Signaling

-PCS_CTRL: 1=channels 25-599, 0=channels 600-1175. Output of Robin to Hornet
-PD_Cell & PD_PCS:. Robin output to Tomcat and Hornet, powers down those chips. 0=off, 1=on
- FALSE_DET: Used by UEM to monitor VR2 to ensure it is low when it should be (*i.e.,* phone not transmitting when it's not supposed to be)
- TX_GATE: used to turn on various blocks. Used with puncturing, and to turn on power down circuits. Input to Robin.
- VREFRF02: Robin input, voltage reference from UEM. Should be 1.35v
- FILSEL1 and FILSEL2: control lines which enable Robin to control the switch N605.

These lines are Robin outputs.

-FilSel1	Fil Sel2	
0	1	channels 25-599
1	0	channels 600-1175

- P_DET: Voltage output of power detector, input to Robin.
- P_REF: Voltage reference from a diode which is the same type as used in power detector.

Used to obtain temperature variations of diode in order to cancel out temperature variations from power detector data. Input to Robin.

- PWROUT: This is an analog Robin output that is proportional to transmitted power (the output of an op amp which subtracts P_REF (reference data) from P_DET (power detector data))., goes to UEM.

- IREF_CEL/IREF_PCS: (names within Robin: PACTRL_ICEL and PACTRL_IPCS) Output from Robin to PA. Within Robin, it's the output of a current mirror that is used to control PA gain. (Therefore the PA_AGC is an input to Robin.)

- TX IF AGC: This is a PDM controlled line. The higher the PDM value the lower the gain.

- TX RF AGC: This is a PDM controlled line. The higher the PDM value the lower the gain

- PA AGC: This is a PDM controlled line. The higher the PDM value the higher the gain

PCS TX Split Band Filter Z601

Due to the close separation between RX and TX bands in PCS compared to the width of the RX and TX bands, a single filter in PCS is not available that gives the required rejection in the RX band, with the required insertion loss in the TX band. Therefore, two filters are used, which are housed in the same package. One filter is for the lower half of the band (channels 25-599), and the other filter is for the upper half of the band (channels 600-1175). Switching circuitry selects the correct path depending on the channel.

Batman (N701) Key Features

- Receiver chip: both Cell & PCS; IS95, IS2000& AMPS
- Input is IF signal, output is baseband IQ
- 84 ball UFBGA
- IF to BB downconverter
- Contains on-chip VHF LO
- Contains IF Variable Gain Amplifier
- Contains baseband filters (BBFIL) and baseband amplifiers (BBAMP) Has digital interface for control by external digital controller

Batman (N701) Signaling

- BAND_SEL: 1=PCS, 0=Cell. Batman output that controls external UHF VCO
- GAIN_CTL: output that controls Alfred LNA. 1=LNA high gain, 0=LNA low gain
- IF_SEL: Output that controls Alfred. 1=AMPS, 0=CDMA
- PURX=power up reset. Batman input.

VREFRF01: voltage reference input from UEM. Should be 1.35v

PA Key Features: Shark (N801, Cell) and Snapper (N802, PCS)

- PAs are 50 ohm input/output with internal DC block.
- MODE signal sets the PA into boost (mode=0) or non-boost (mode=1). Boost mode causes the PA to draw more current in order to improve linearity (which decreases Power Added Efficiency). Boost Mode is used in CDMA (both IS2000 and IS95, both Cell & PCS) above +21 dBm transmit power.
- Biased directly from battery.

IREF: input to PA from Robin that controls gain of PA.

LNA/Downconverter (N750) Key Features

Alfred (N750) Key Features

- Front end Receiver chip
- Contains PCS and Cell band fixed gain LNAs that can be switched in or out.
- Contains PCS and Cell band RFAs
- Contains RF to IF downconverter
- Contains fixed gain IF amplifiers, one for CDMA (PCS and Cell) and one for AMPS

Hornet (N602) and Tomcat (N603)

Hornet (PCS) and Tomcat (Cell) are driver amplifiers whose outputs are connected to the TX filters. Hornet has one input and two outputs, since the output is connected to the split band filter. Both are powered directly from the battery.

APPENDIX E: AGC Algorithms

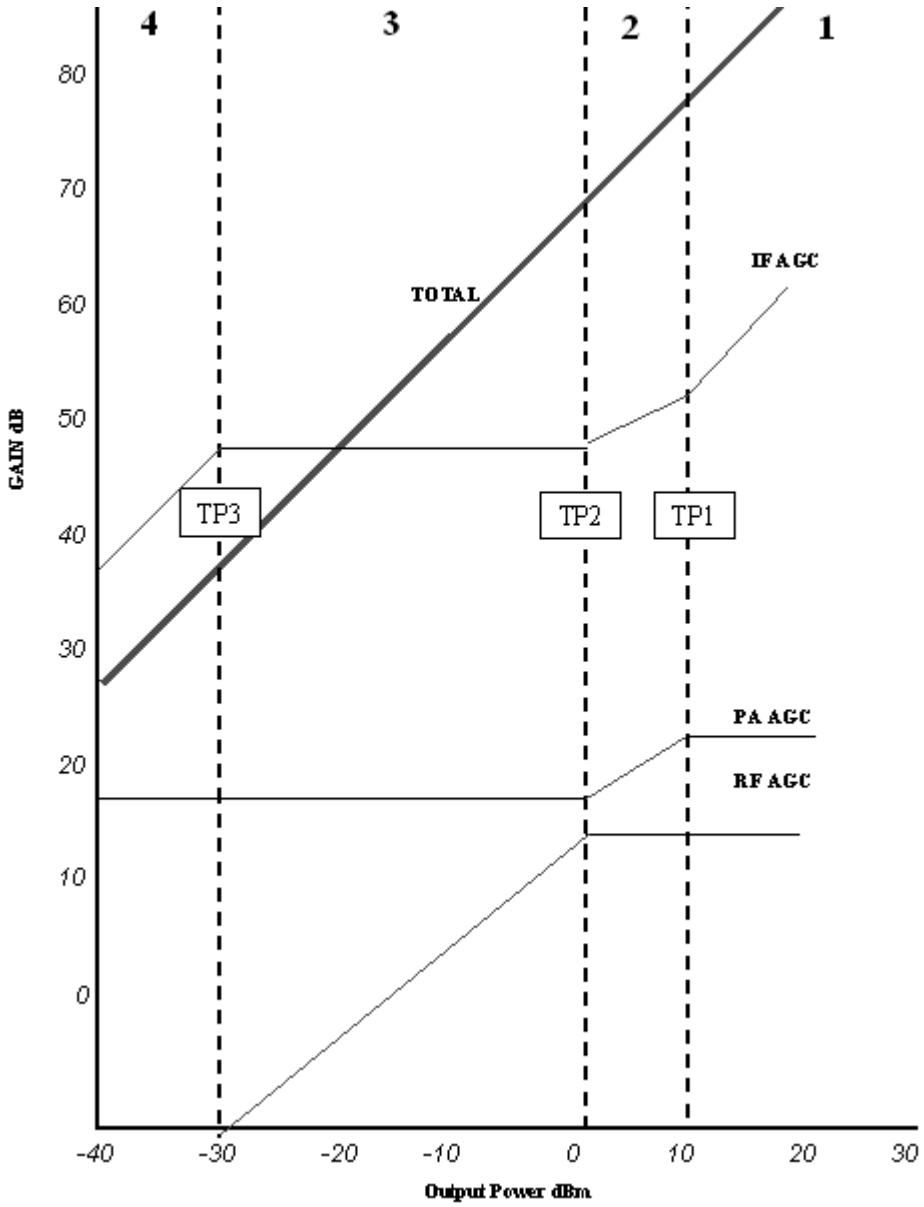


Figure 19: CDMA (Cell and PCS) AGC Algorithm

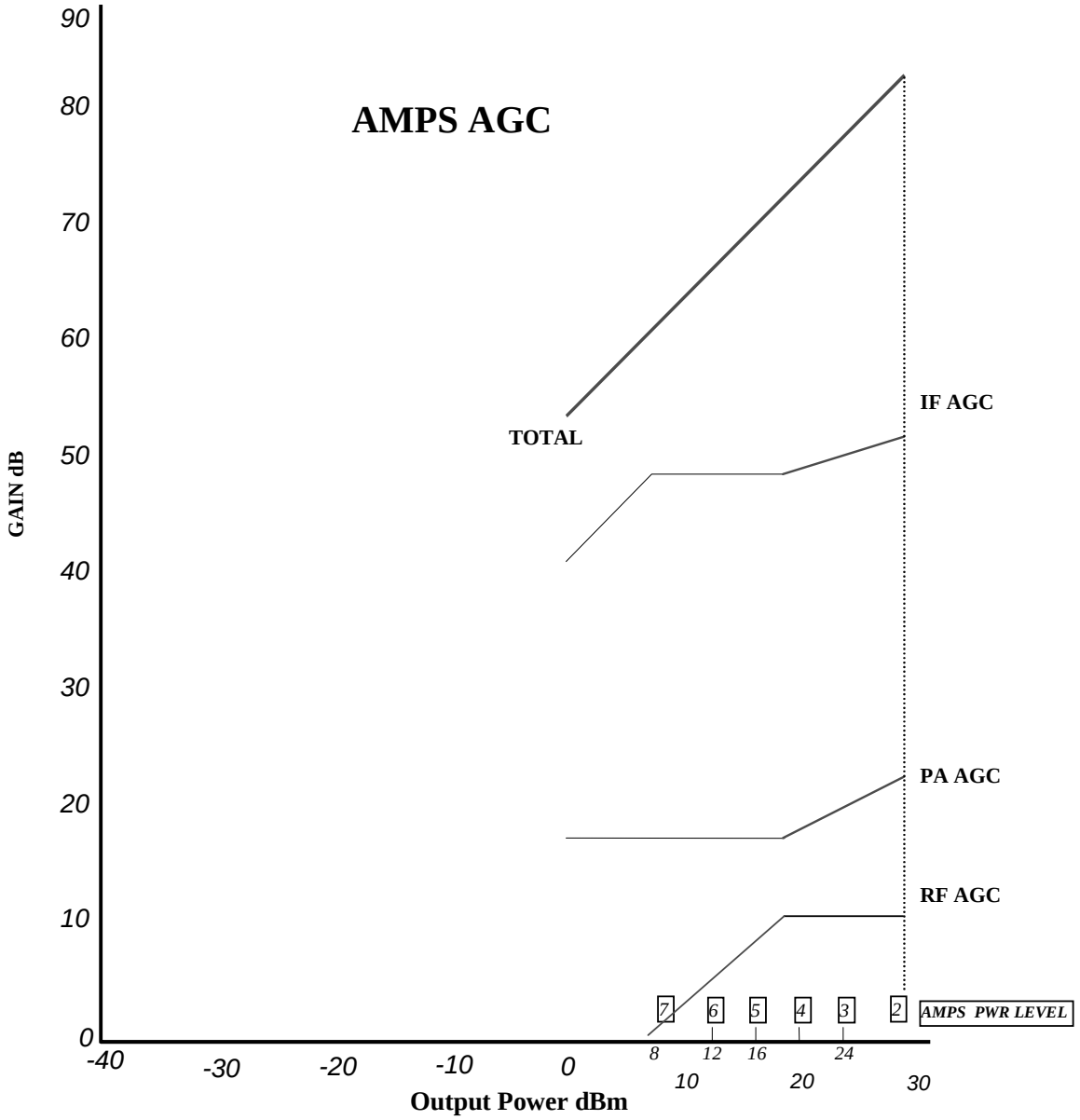


Figure 20: AMPS AGC Algorithm